

FAUNAS OF THE PARADOXIDES BEDS IN EASTERN NORTH AMERICA, NO. 1.

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The following article is a contribution to a revision of the faunas of the Paradoxides beds as they are developed in eastern North America. The region where these beds are found is spread along the Atlantic sea-board from New Foundland to eastern Massachusetts, and it is not known that the genus Paradoxides existed west of the Braintree basin in that State.

In this article only the smaller crustaceans, including two genera of trilobites, are treated of. But these small fossils are as valuable for the correlation of horizons as the larger species, for they were as sensitive to a change of conditions as those, and tell the story of the subzone which they mark with as great certainty as Paradoxides itself. In fact, they are even of higher value for this purpose, as a small piece of shale will contain a fully characterized example.

In the author's former paper* an outline was given of the Cambrian system in eastern North America and its faunas, so that it seems unnecessary here to do more than call attention to the sub-divisions of the Paradoxides sub-faunas as they are developed in this region. We know of the occurrence here of

*The Protolenus Fauna. New York Acad. Sci., Vol. XIV., p. 101.

four of the six sub-faunas into which the *Paradoxides* fauna is divided viz:

The Sub-zone of	<i>P. lamellatus</i>	Hartt (cf. <i>P. Oelandicus</i>).	12.1.
"	"	" <i>P. Eteminicus</i> (cf. <i>P. rugulosus</i>).	12.2.
"	"	" <i>P. Abenacus</i> (cf. <i>P. Tessini</i>).	12.3.
"	"	" <i>P. Davidis</i> .	12.4.

The first of these sub-zones is the oldest *Paradoxides* fauna of which we have any knowledge, and so far has been recognized in two countries only, viz., Sweden in Europe, and New Brunswick in eastern Canada. It is characterized by Hartt's species, *P. lamellatus*, easily recognized by the interrupted, raised plates on the front of the glabella; the varieties of *Conocoryphe* and *Ctenocephalus* which occur here have more hispid tests than those of the next sub-zone. This sub-zone is the home of *Microdiscus Dawsoni* and *Liostracus tener*,* and occurs in Sweden.

The next sub-zone, that of *P. Eteminicus*, has a wide range on both sides of the Atlantic, but seems to be most fully represented in the southern regions of the area over which the genus *Paradoxides* was spread. It is the most prolific band of the *Paradoxides* beds in New Brunswick, and is the only sub-zone recognized in Massachusetts, France and Spain; the species cited by Walcott indicate its presence in Newfoundland; it occurs in Wales as the Solva group (or in that group); it is present in Bohemia, and is sparingly represented in Sweden in the "Exsulens Kalk."

The third sub-zone, that of *P. Abenacus* (a species closely allied to *P. Tessini* of Sweden and *P. Bohemicus* of Bohemia), is represented in New Brunswick by a well-marked fauna, in which *Ptychopariæ* and *Solenopleuræ* abound. *Microdiscus pulchellus* is a characteristic species of this sub-zone, and it is a stronghold of the genus *Agnostus*. This sub-zone is doubtfully present in Newfoundland,† but it is in full force in Norway, Sweden and Bohemia.

The highest sub-zone so far recognized in America is that of *P. Davidis*, which has a full representation at several localities in Newfoundland. It is characterized by the genus *Anopolinus*, by the species *Microdiscus punctatus* and by large *Agnosti*, including examples of the Section *Lævigati*. This sub-zone is

*Walcott catalogues this species from Newfoundland as occurring in his zone A at Manuel Brook, but the species quoted by him as associated with it there, are of the next sub-zone.

†I have spoken of this horizon being present there (Trans. Roy. Soc. Can., Vol. IV., p. 156) at Chapel Arm, but the presence of *Anopolinus* seems rather to indicate the next sub-zone. In Mr. Walcott's Zone B, of the Manuel Brook Section there is a mixture of the species of the second and fourth sub-zone, but the presence of species of the intermediate zone does not distinctly appear.

well marked in Wales, where the species *P. Davidis* was discovered, and it is fully represented in Sweden.

The other two sub-zones of the Paradoxides beds are not known to be represented in America, and so far as the author knows, have not been recognized outside of Scandinavia. That of *P. Forchammeri* is contained in the Andrarum limestone, a very rich repository of Cambrian forms, where the Paradoxides fauna may be said to have culminated. The higher of these two sub-zones contains only the dying remnants of this fauna and is known as the Zone of *Agnostus lævigatus*. Rare remains of a Paradoxides related to *P. Tessini* have been found in it. I. D. Wallerius has lately described a number of new genera, species and varieties from this sub-zone in Sweden.

The following is in brief the range of the American subfaunas of Paradoxides so far as known:

Sub-zone of *P. lamellatus*—New Brunswick only.

Sub-zone of *P. Etminicus*—New Brunswick, Newfoundland and Massachusetts.

Sub-zone of *P. Abenacus*—New Brunswick and Newfoundland (doubtfully in the latter province).

Sub-zone of *P. Davidis*—Newfoundland only.

DESCRIPTIONS OF GENERA AND SPECIES.

PHYLLOPODA?

As compared with the Phyllopod crustacean of the Olenus and higher zones the fossils described below are very small. Their minuteness is an obstacle to the study of their characters, for there has been sufficient molecular movement in the shales in which they are imbedded to obscure the surface markings of such delicate fossils as these. They are supposed to be crustacean on account of the long, straight hinge line and weak umbones and their defined bordering rim.

LEPIDITTA.*

Obliquely semi-circular or semi-elliptical bivalves, wide on the anterior half of the valve and having a long, straight hinge line; umbones in front of the mid-length of the hinge, low or but moderately elevated.

LEPIDITTA ALATA (Plate XV., figs. 1a and 1b).

Lepidittha alata, Trans. Roy. Soc. Can., Vol. III., pt. iv., p. 61, pl. vi., figs. 16, 16a.

* Trans. Roy. Soc. Can., Vol. III., pt. iv., p. 61.

Valves obliquely semi-elliptical, about one-third longer than wide; hinge line straight, umbo less than one-third from the front of the valve. Tumid part of the valve occupying about one-third of its length and about one-half of its width; valve flattened toward the anterior and posterior ends. A faint narrow rim is traceable around the outer edge of the valves.

The cast of the right valve has a triangular umbonal prominence, about one-third from the front; the prominence is limited in front by a sharp and deep furrow, placed at right angles to the hinge line, and extending thence toward the base of the valve; the umbonal elevation is somewhat hollow in the middle, where it bears a sharp, narrow ridge, which is directed toward the posterior margin, at an angle of 50° from the hinge line; a faint furrow connects this ridge with the point of the umbo.

The outer surface of the valves of this species is marked by numerous concentric striae, and by two faint radiating furrows, extending on each side of the tumid part of the valve to the basal margin.

The sharp median ridge and connected furrow, seen in the cast of the right valve of this species, are similar to those on the dorsal valves of some Brachiopods, but the position of the umbo separates it from that class of molluscs.

Length, 1 mm. Width, $\frac{2}{3}$ mm.

Horizon and Locality. In the fine, gray shales of Div. 1. c, at Hanford Brook, St. Martin's. Infrequent.

LEPIDITTA CURTA (Plate XV., fig. 2).

Lepiditta curta, Trans. Roy. Soc. Can., Vol. III., pt. iv., p. 61, pl. vi., fig. 17.

Obliquely semi-elliptical and about two-sevenths longer than wide; hinge line nearly straight; umbo depressed, less than one quarter from the front of the valve. Valves flattened toward the base and posterior end, the anterior margin has a flattened, depressed rim; and the front of the rim in the two valves was apparently connected by a triangular piece not bounded by distinct sutures.

The interior of shell has roughened zones or undulations concentric to the umbo.

This organism is not unlike the crustaceans of the genus *Estheria*, but its resemblance to the preceding species, in form and hinge characters, indicates a generic relation.

Length, $1\frac{1}{2}$ mm. Width, $1\frac{1}{4}$ mm.

Horizon and Locality. In the fine dark shales of Div. 1.d¹, at Porter's Brook, St. Martin's. Rare.

LEPIDITTA AURICULATA (Plate XV., figs. 3a and 3b).

Lepiditta auriculata, Trans. Roy. Soc. Can., vol. xi., pt. iv., p. 99, figs. 2 a and b.

Only a mould of the left valve is known. This is purse-shaped and has a short ear at each end of the hinge line. There is no marginal rim. Two grooves in the mould at the hinge line show that the hinge had two oblique plates towards the posterior end.

The surface of the mould is highest a short distance below the hinge, whence it descends gradually to the posterior margin, where the valve is nearly flat. This mould also shows faint, parallel ridges, concentric to what is supposed to be the anterior end. Faint lines mark off three quadrate spaces, near the hinge, parallel to the long plate, and corresponding in position to the upper seal-like marks of *L. sigillata* of the Protolenus Zone (Div. 1 b. 3).

Size.—Length, 4 mm.; width, $3\frac{1}{2}$ mm.; height of one valve, about $\frac{1}{4}$ mm.

Horizon and Locality.—In the fine olive gray shale of Div. 1 c at Hanford Brook, S. Martin's.

This species is something like that which Mr. C. D. Walcott refers to *Nothozoe Vermontiana*, but has a longer hinge line and is more triangular in form; it is also much flatter than that species. Its long hinge line and hinge plates show it to be of the genus *Lepiditta*.

OSTRACODA.

After the abundance of individuals and the variety of form in the Ostracoda of the Protolenus Fauna, the few found in the Paradoxides bed is somewhat of a surprise. Perhaps the Agnosti so common in the fine shales of bands c and d usurped the place of the Ostracoda.

PRIMITIA, Jones.

This genus is represented by more than one species in the rocks of the St. John group, and the author proposes to describe here a very tumid form, of which a few individuals have been found.

PRIMITIA ACADICA (Plate XV., figs. 5a-c).

Primitia Acadica, Trans. Roy. Soc. Can., vol. iii., pt. iv., p. pl. vi., figs. 22. 22 a and b.

Outline of the valves elliptical-oblong, with but very slight

projection at the extremities of the hinge line. The valves slope down in all directions to the margin, and the form is so symmetrical that it is difficult to ascertain which is the upper and which the lower side of the valve; but the side on which an obscure marginal fold is found, is supposed to be the lower side. It is also difficult to say which is the anterior and which the posterior end of the valve; one end has a low tubercle and a shallow pit, while the other end is plain; this distinction may be used for the purpose of locating the characters of the inner surface of the test, as seen on the mould of the valve.

The center of the valve is marked by a distinct circular depression, apparently a perforation of the test: from this point a faint medium furrow extends toward the tuberculated end, where it fades out in the shallow pit existing at that end of the valve; this pit is larger than the circular depression at the center of the valve, but differs from it in having no defined margin; beside this larger pit, but nearer to the margin of the valve, is the tubercle above referred to; it is low, somewhat pinched up at the sides, and elongated in the direction of the larger axis of the valve. The slope of the sides of the valve near the margin is nearly vertical, and the marginal fold is very feeble and obscure.

The surface of the valve is granulated, but the granulations are more distinct on the inner than the outer surface; the inner surface is more brilliant than the outer.

This *Primitia* resembles in form and size the Silurian *P. transiens*, Bar.; its apparently perforated disc recalls another Bohemian species, *P. perforata*, Bar.; in this species the perforation and tubercle are situated near the hinge line, but in ours near the axis.

Length, $3\frac{1}{2}$ mm.; width, 2 mm.

Horizon and Locality.—In the conglomerate-limestone band, Div. 1.c¹, at Porter's Brook, St. Martin's.

In his article on the Olenellus Fauna, of Washington county, New York,* Mr. C. D. Walcott has described a peculiar Entomostracan with a flexible test under the name of *Lepertitia* (*I. dermatoides* with the remark, "It may be that this species should be referred to a new genus." This fossil resembles one which the author has had in his hands for some time, undescribed. The peculiar wrinkling of the test (under pressure?) separates these fossils from all other Cambrian Ostracoda, and they are here placed in a new genus.

*Fauna of the "Upper Taconic" of Emmons, in Washington county, N. Y., by C. D. Walcott. Am. Jour. Sci., vol. xxxiv., Sept., 1887.

ALUTA, n. gen.*

Small bivalves similar in form to *Aparchites* (oval or ovate), but having a soft, flexible test, and a fine somewhat distinct punctation of the surface. There is no marginal fold or a very narrow one.

ALUTA FLEXILIS, n. sp. (Plate XV., fig. 4.)

Oval about one-half longer than wide, and having a very narrow rim. At the anterior upper corner is a tubercle (ocular?) enclosed by a shallow furrow. Towards the back on the upper part of the valve (in the only example known) is a broad, shallow, circular pit; irregular undulations impress the surface of the valve elsewhere.

Sculpture.—Minute, rather distinct punctures.

Size.—Length, $3\frac{1}{2}$ mm.; width, $2\frac{1}{2}$ mm.

Horizon and Locality.—A calcareous band in Div. 1. ^{ci} at Porters Brook, St. Martin's, N. B. Scarce.

This species in the position of the ocular (?) tubercle resembles *Primitia oculata* of the Protolenus Fauna, but the form of the shield is different. The species is also near Walcott's *Leperditia dermatoides*, which, although figured as ovate (if one may judge by the description), include oval forms as well; that the author makes no reference to an ocular tubercle, so we find it necessary to make a specific description.

The flexible wrinkled test causes this fossil to be overlooked as the embryo of some trilobite, but there is no trace of an axial ridge.

CIRRIPEDIA. *He*

While skeletons of creatures referred to this group of crustaceans have been found in considerable numbers in the Cenozoic and Mesozoic rocks they are in lessened numbers in the earlier deposits; and they are more difficult to recognize on account of their wide departure in the details of structure from existing types. Nevertheless we now find Cirripedes recognized as members of all the great faunas from the Ordovician onward, but the writer is not aware that any remains referable to these creatures have been reported from faunas antecedent to the Ordovician; he, however, believes that such remains are present in the Cambrian rocks and proposes to describe herein such as appear to have belonged to Cirripedes.

None of these occur contiguous to each other as to suggest the remains of one individual such as enabled Dr. Henry Wood-

* *Aluta*, leather.

ward to describe *Turrilepas*, or J. M. Clarke, *Strobilepis*, or C. L. Faber, *Lepidocoleus*, or J. Barrande, *Plumulites*, but when similar objects are found in the Cambrian system no doubt these genera will throw light upon them.

The remains found in the Cambrian rocks of eastern North America are only scattered plates of the exoskeleton, and they are described largely with the object of inviting attention to the plates of this kind, not at all rare in some layers of the fine shales of the Lower Cambrian, which appear to be referable to *Cirripedes*. Of the genera mentioned above *Plumulites* appear to be recognizable in certain plates found in the *Paradoxides* beds of Newfoundland.

PLUMULITES Barrande.

In 1846 Barrande observed in the Ordovician rocks of Bohemia some peculiar plates of sub-triangular form and strongly ribbed transversely, which he called *Plumulites*. Eleven years later he found plates of this kind grouped together in such a way as to show the kind of animal to which they had belonged. In 1864 Prof. Reuss, in connection with a memoir on the *Lepadidæ* of the Oligocene of Germany and chalk of Galicia, took occasion to point out that the *Plumulites* of Barrande were remains of *Cirripedes*.* In 1865 Dr. Woodward referred the valves from the Silurian beds of Dudley, Eng., which de Koninck had called *Chiton Wrightianus* to the *Cirripedes*, under the name of *Turrilepas*. Thus by degrees the proper zoological position of these peculiar valves or plates, usually found loose and scattered in the shales of the Paleozoic rocks, came to be recognized.

Barrande's description of *Plumulites* is somewhat diffuse, and has been summarized by Zittel as follows:† Body elongated, resembling a pine cone, clothed with 4-6 (or more) longitudinal series of scaly plates. The plates are covered by strong transverse striæ, somewhat in relief, and have a triangular form; the median series are ordinarily distinguished from the lateral by their more convex form, and by the presence of a median keel. Barrande also found a peculiar, more oval valve in which the striæ encircled the upper end, which valve he called *valve fenêtrée*.

Plumulites has been found in the Ordovician (where it was first recognized) of Bohemia and Ohio, and similar plates in the Silurian of England and the Devonian of New York; it has not hitherto been reported from the Cambrian.

The presence of so highly differentiated a class of Crustaceans

*Syst. Silur. Bohême vol. I., Supp. p. 506.

† Traité de Paléontologie. Zittel and Barrois. vol. II., p. 533.

almost at the beginning of Cambrian time is a proof, if any were wanted, of the very early origin of the Crustacean stem; and the rarity of plates that are found in the Paradoxides beds are sufficient to show that we are as yet but very imperfectly acquainted with these ancient types of Cirripedes.

Barrande found the triangular valves of *Plumulites* three-lobed, by zones diverging from the apex, each having its peculiar sculpture. In describing these valves we propose to follow his nomenclature, the two slopes being designated respectively the convex and concave sides, and the third side (by which the valve was attached) the base.

PLUMULITES MANUELENSIS, n. sp. (Plate XIV. fig. 7.)

A triangular plate with curved sides, one concave, the others convex, rather blunt at the apex, somewhat straight along the base. A band different in elevation from the rest of the surface of the plate traverses it from apex to base and is nearest the concave side. There are about fourteen strongly marked transverse ridges traversing the plate, parallel to the base.

Sculpture.—Fine striæ (about four to a ridge) on the transverse ridges.

Size.—Length, 4 mm.; width, $3\frac{1}{2}$ mm.

Horizon and Locality.—Soft gray shales of Div. 1 d^2 , at Manual Brook, Conception Bay, Newfoundland. Scarce.

This resembles in shape Barrande's *P. compax* of the Ordovician of Bohemia, but is straighter along the base and more strongly arcuate in outline above the base.

It is with great hesitation we refer the following genus to the Cirripedes as possibly representing the terminal plate of some such form as *Strobilepis*, or anchylosed plates similar to the terminal pair in *Lepidocolens*; but it seems as likely a relation as any other that has been suggested.

STENOTHECA Salter.

This genus was proposed by Mr. J. W. Salter (published by Dr. Henry Hicks, in 1872), to include a minute corrugated shell, found in the Menevian group in Wales. It was described as a "curved shell, a small wide form, with lines of growth strongly marked on its surface." The only species figured is *S. cornucopia*.

The genus is represented in the St. John Group at one locality by numerous examples from the horizon $1d^1$ in a fine, dark shale. The little cones of this genus are always flattened, inequilateral, and usually have a more or less rigid band along

the back. Though shorter and wider these objects are not unlike plates of Plumulites, not only do they have the same sharp, transverse ridges, but a similar arched band extends across the middle, from the apex. This genus when described was placed by its author among the Pteropods, but if I am right in having referred to it certain small fossils of the Paradoxides beds, there would seem to be features indicating affinities with the Crustaceans, and especially with the ancient Cirripedes, rather than the Pteropods.

and Stenotheca had thin calcareo-chitinous shells similar to the tests of trilobites, sharply raised ridges parallel to the lower border; the apical angle was bounded by two sides, one of which was convex and the other concave. The convex side is called dorsal, and the concave ventral, the third side is the aperture or base.

STENOTHECA CONCENTRICA. (Plate XIV., fig. 1.)

Stenotheca concentrica, Trans. Roy. Soc., Vol. III., pt. iv., p. 59, pl. vi., fig. 11.

Amended description. Outline of the compressed fossil rudely lenticular, the dorsal and ventral slopes being together equal to the strongly arched apertural margin. The apex varies from a bluntly rounded form to one which is prolonged into a short triangular point. For about one-third from the apex the surface has irregular undulations, about seven in number, concentric to the apex, and the rest of the test on the ventral slope about eight strongly marked ridges, concentric to the apex; these ridges are increased on the dorsal slope to the number of twelve or thirteen by the intercalation of additional ridges in the dorsal third.

Sculpture. The surface appears to have minute pores and is ornamented with linear ridgelets which have a roughly parallel and sometimes anastomosing arrangement. The most typical form of ornamentation is a chevron or zigzag arrangement of minute ridges, visible only with a lens, and most marked on the outer part of the shell; these chevron lines sometimes cross two of the concentric ridges before turning and usually run angling across the ridges. The chevron sculpture varies to an irregular wavy arrangement of ridgelets, and that to a more or less linear grouping, which is the usual appearance of the ornamentation at the apex: occasionally straight lines on the primary ridges, alternate with wavy or somewhat zigzag lines in the hollows between. Another occasional variety of the sculpture is that of irregular wavy ridgelets crowned by little tubercles along the summit of the ridgelets; this gives the effect of a cancellated surface.

Size.—Height of the summit of the dorsal curve above the aperture, 3 mm. Length of chord of dorsal curve, $3\frac{1}{2}$ mm. Length of aperture, $4\frac{1}{2}$ mm.

Horizon and Locality.—In the fine, dark gray shales of Div. 1 d.¹, at Porter's Brook, St. Martin's. Not infrequent.

This species may be compared with *S. Cornucopia* Salt. of the Menevian Group, in Wales; it differs in having a wider aperture and more strongly arched dorsal slope.

Six years ago a close examination of the surface characters led the author to refer this object (and its genus) to the Crustacea, chiefly from its punctate surface and from the fact that the sculpture showed more distinctly on the inner surface than the outer. The shell substance was also found to be calcareo-corneous, like that of the trilobites and other Crustaceans.

Var. RADIATA. (Plate XIV., fig. 2.)

Stenotheca radiata. Trans. Roy. Soc. Can., vol. iii., pt. iv., p. 57, pl. vi., fig. 12.

Outline lenticular, more strongly arched on the apertural than the dorso-ventral side; dorsal slope about three times as long as the ventral; apex larger and more prominent than in the type; ventral slope more concave; a sulcus about one-third from the dorsum, arching from the apex to the base, usually delimits the dorsal zone from the rest of the plate. There are about five irregular, concentric ridges on the apical part and ten more distinct and regular ones on the rest of the plate.

Sculpture.—Differs from that of the type in the general absence of the chevron pattern (though in a band extending along the middle and at the outer margin this pattern sometimes appears), but generally the arrangement of the ridgelets is irregularly linear.

Size.—Usually somewhat smaller than the type.

Horizon and Locality.—In the gray shales of Div. 1 c at St. John; rare; also in the dark gray shales of Div. 1 d.¹, at St. Martin's; more common.

The example of this variety from Div. 1 c is smaller than those from Div. 1 d.¹, and has striæ radiating from the apex.

A comparison of these little plates with the triangular plates of *Plumulites* will show that they are much alike, the essential differences being the doubling of the plate in *Stenotheca*, its broader aperture and the insertion of additional ridges near the dorsum. The Cambrian fossils have the same sharpness and close opposition of the ridges, and in a less distinct degree the radial banding from the apex. Though we noted the points of

resemblance in composition and sculpture between these plates and the tests of trilobites some years ago, we did not then suspect them to be parts of Barnacles, and it was only after finding the plates of another species (*S. triangularis*) in intimate relation to the detached plates hereafter described as Cirripodites that we were led to suspect that they might be parts of Barnacles, and possibly such a hollow caudal plate as Dr. Clarke figures for *Strobilepis*. If we admit this, however, we must also be prepared to allow that while this caudal plate was of calcareo-chitinous composition the lateral plates of the same creature were thicker and calcareous.

Another possible explanation of these little plates is that they correspond to the dorsal row of small conical plates such as is seen on *Strobilepis*, but this seems less likely on account of their comparative thinness and flexibility.

Among the fossils of the St. John group which the author in previous papers has assigned to *Stenotheca* there are two types, that just described and another chiefly characteristic of a lower horizon. It is true that all these minute fossils have certain characters in common, as the compressed conical form, the strong ribbing of the surface and the thickened dorsal band. But they have also points of difference, for in the forms described below the ribs (except in one) do not increase in number on the dorsal side; they are more distant from each other, and there are pores or perforations at their extremities; these pores or holes form a row along the dorsal ridge and sometimes also along the ventral.

The acquisition of better examples of *Stenotheca triangularis* than were in hand when this form was described, has led the writer to conclude that there are important differences between it (and some others described with it) and the typical *Stenotheca*, enough to constitute specific, if not generic differences between them, if they were complete organisms; but as they are possibly only parts of organisms it is unnecessary to make any generic distinction until the general structure is known.

In the first examples studied it was not observed that the surface visible was not the outer surface of the test, but the surface of the mould of the interior, and the "long cylindrical apex" described and figured is really an internal tube in the apex of the cone.

STENOTHECA TRIANGULARIS. (Plate XIV., figs. 4a and 4b.)

Stenotheca triangularis, Trans. Roy. Soc. Can., vol. iii., pt. iv., p. 58, pl. vi., figs. 5 and 5a.

Stenotheca triangularis, Trans. Roy. Soc. Can., vol. viii., pt. iv., pp. 133, 134.

Amended Description.—Form conical with an oval base and bluntly pointed apex. Viewed laterally the cone has a dorsal edge moderately convex, and a ventral edge slightly concave; the base is straight for two-thirds of its length and turned up at each end. The orifice of the cone is a flattened oval twice or three times as long as wide; the side of the cone is encircled by about six undulations of growth which arch upward around each end, corresponding to the curving basal margin. The cone has in its apex a short, annulated tube, about as long as the space between two of the transverse ridges of the surface. The upper two-fifths of the cone is thickened, and between this part and the base the cone has four perforations along the dorsal slope, and there are perforations (four?) also along the ventral slope. On the inner surface of the cone there are sharp, engirdling grooves corresponding to the rounded ridges on the outside, and opposite the dorsal and ventral perforations these grooves, where they meet from the opposite sides of the cone on its inside, are enlarged into a cup-shaped cavity.

Sculpture.—The rounded ridges of the surface are each traversed lengthwise by about six striæ, visible only with a lens.

Size.—Height $4\frac{1}{2}$ mm; length of base 5 mm.

Horizon and Locality.—Fine grey shales of Div. 1 c², at St. John and Hanford Brook, St. Martin's. Infrequent.

This fossil has a thicker and firmer test than the two preceding kinds. The perforations recall those seen on the appendages of crustaceans as for instance those of Phyllopods, figured by Barrande,* and it appears probable that they are the points of attachment of mobile spines. Clarke figures a row of such in *Strobilepis*, but not as being connected with the terminal plate.

STENOTHECA NASUTA. (Plate XIV., figs. 6a and 6b.)

Stenotheca nasuta, Trans. Roy. Soc. Can., vol. iii., pt. iv., p. 58, pl. vi., fig. 13.

Amended description.—Conical, subtriangular in side view, with deeply concave ventral slope and convex dorsal slope. Orifice of the cone strongly arched. As preserved in the shale there is a smooth raised band both on the dorsal and ventral slope, that on the former being wider; in the space between are about six rounded concentric ridges, parallel to the base.

Sculpture.—The surface is smooth, or nearly so, except on the dorsal band, where a number of faint striæ, concentric to the apex, are made visible by a lens.

Size.—Height, about $2\frac{1}{2}$ mm.; length of base, $8\frac{1}{2}$ mm.

*Système Silurien de Bohême, vol. I., supp., pl. 19, figs. 6, 8, 10, &c.

Horizon and Locality.—Fine gray shales of Div. 1 c., at Hanford Brook, St. Martin's, N. B., Canada. Rare.

Other examples of this form show the apex to be acute. Bosses on the surface indicate that the transverse grooves of the interior terminate near the dorsal margin in a cup-shaped enlargement similar to that of *S. triangularis*, but no perforations of this margin have been detected. Both the dorsal and ventral zones of the shell are thickened, and the concentric ridges scarcely show there.

STENOHECA HICKSIANA. (Plate XIV., fig. 3.)

Stenoheca Hicksiana, Trans. Roy. Soc. Can., vol. iii., pt. iv., p. 56, pl. vi., fig. 14.

Amended description.—Conical, subtriangular, with strongly arched convex slope, and a concave slope which is strongly curved near the apex, but is straight for the lower two-thirds; the base is nearly straight for two-thirds of its length, but curves upward toward the convex slope; apex not known. The cone is compressed and carries on its side about ~~two~~ ^{five} ridges on the concave side and ~~five~~ ^{seven} on the convex, owing to intercalation of additional ridges; perforations of the shell opposite some of these ridges, on the dorsal line.

Size.—Height, 3 mm.; length of base, 3½ mm.

Horizon and Locality.—Dark grey shales of Div. 1. d. ¹ at Porter's Brook, St. Martin's N. B., Canada. Rare.

The comparatively few ridges ally this form with the succeeding ones.

CIRRIPODITES n. gen.

Small calcareous plates of peculiar contour and relief have from time to time been found in the beds which carry the remains of Eocystites; these plates are of such form that they do not appear to be of this genus, and the author has come to regard them as the covering plates of one or more species of Cirripedes. A symmetrical plate is rare among them, but they are usually characterized by one or more low keels with the surface somewhat depressed on one side of the keel and elevated on the other; many of them also have a deep furrow at one side, transverse to the keel. In their thickness and calcareous composition they resemble plates of Eocystites, to which some of them may belong.

Complete skeleton unknown. The remains consist of small, thick, calcareous plates, usually asymmetrical in form, smooth, but having growth lines along the margin. The following are the chief variations in form:

Type A, Plate XIV., Figs. *a* and *b*.

Oval plates, usually rather flat, having a strong ridge lengthwise, and often a more obscure, obliquely transverse ridge. The form is not a true oval, and is usually more angulated on one side than the other.

Size.—Length, 6 to 8 mm.; width, 4 to 6 mm.

Type B, Plate XIV., Figs. *c* and *d*.

Semi-ellipsoid plates. These also are nearly flat and have a slight furrow along the straight side. From near the center at one side faint furrows radiate toward the rounded margin. Some of these plates have two long sides nearly parallel.

Size.—Length, about 8 mm.; width, about 4 mm.

Type C, Plate XIV., Figs. *e* to *h*.

Roughly semi-circular plates, with or without a flange on the straight side. Between the flange and the body of the plate is a deep furrow; body of the plate elevated and having an umbo which overhangs the furrow and from which a low ridge extends toward the rounded, often emarginate or obtusely pointed opposite margin. Usually the plate is depressed on one side of the keel and elevated on the other, and there are sometimes obscure subsidiary ridges radiating from the main keel or ridge. The flange is usually wider at the sides, and reflected backward, or emarginated in the middle. These resemble the peripheral plates of *Trochocystites*, Barrande.

Size.—Length, parallel to the furrow, 5 to 8 mm.; width, 3 to 5 mm.

Type D, Plate XIV., Fig. *i*.

Ovate plates with pointed end. These have a distinct furrow along the axial line; they are convex all around, and have a short ridge inside near the apex.

Size.—Length, 6 mm.; width, 5 mm. Rare.

Type E, Plate XIV., Fig. *k*.

Triangular plate rather flat, having ridges diverging toward the rounded corners; ridges increasing in width and more prominent toward the outer ends. This plate may belong to a *Cystidian*.

Size.—Length and width, 5 mm. Rare.

Type F, Plate XIV., Figs. *l* and *m*.

Sub-triangular plates, rather flat, with curved margins, one concave and the other convex. An arched furrow, nearer one margin than the other, traverses them.—*Cirripodites cambrensis*.

Type G, Plate XIV., Fig. *n*.

Triangular plates of high relief, sometimes showing facets of contact on the sides next the pointed end. One side of the plate rounded.

Size.—Length, 4 to 5 mm.; width, 3 to 4 mm.

Sculpture.—All these forms of plates, except for the keels and furrows described, have a comparatively smooth surface, there being only obscure lines of growth, and these not usually seen except toward the edges of the plates, and to these edges the lines are parallel.

Horizon and Locality.—Gray shales of Div. 1 c at St. John and Hanford Brook, St. Martin's. Somewhat rare.

The reference of these plates to Cirripedes is largely a matter of conjecture. As oval and circular plates have been found to occur along the dorsum of several genera of fossil Cirripedes plates of the type *L* and *D* may have had such a position, those of type *B* are evidently lateral, though the elongated form is unusual. Plates of the type *C* are more plentiful than the others and have the appearance of overlapping lateral plates. I have seen plates from the crown and lateral edges of a Trochocystites that resemble these, with similar flange and furrow. Plates of the type *F* more nearly resemble the opercular armature of modern Cirripedes, and seem to be the representatives in the old rocks of the conical plates of Plumulites,* and are perhaps scutal plates, while the type *G* is analagous to the laterals of such a genus as Scalpellum.† The longitudinal curved ridge of type *F* is comparable to those figured by Barrande. Hall and J. M. Clarke.‡

The broad sub-semicircular or subtrapezohedral form of many of these plates may seem unusual, but is not without a precedent in extinct genera, as Archæolepas and Loricula, which have rows of similar broad plates on the peduncle.§

In the shales which contain *Plumulites Manuelensis* at Manuel Brook, Newfoundland, are casts of calcareous plates which are similar to the above, thus resembling the coronal plates of Trochocystites; but they are different in form from those of the Eteminicus zone at St. John; the commonest form has a very heavy keel or furrow and is truncated at each end. The material is insufficient to determine the nature of these plates, which are sparsely scattered over layers in which *Microdiscus punctatus* abounds.

TRILOBITA.

AGNOSTUS, Brongniart.

This is the most aberrant of all the primordeal trilobites of common occurrence, and the most difficult to associate with the

*Syst. Silur. Bohem., vol. 1, Supp. pl. 20, figs. 7, 8 and 9 b. Pal. N. York, vol. vii., pl. xxxvi., figs. 1 and 3.

†Traité de Paléontologie, Zittel & Barrois, tome ii., p. 596.

‡Syst. Silur. Bohem. vol. 1, Supp. pl. 20, figs. 22, 1 a and 5 b; also Pal. N. Y., vol. vii., pl. xxxvi., figs. 10, 11 and 16.

§Traité de Paléontologie, Zittel and Barrois, p. 533 and 534.

others by features held in common. The abortion of the posterior lobe of the glabella, the absence of the occipital ring, the immutable number of two joints in the thorax, all show the divergence from the common type; and also there is seldom seen on an *Agnostus* the proof of that development and expansion of the pygidium which can be traced in the moulding of the surface of this shield in most other primordeal trilobites.

Nevertheless there are some indications of a closer resemblance between *Agnostus* and its allies in the earlier stages of growth than appear in the adult trilobite. Owing to the minuteness of the shield in the young of this genera, it is difficult to make out the outline and contour of the test in the early stages; but it may be said that the pygidium is proportionately broader and both the marginal fold and furrow wider than is found to be the case at a later period; in the early larval stages it thus approximates more in form and contour to other trilobites than at a later period.

By comparing different species of *Agnostus*, and by a close examination of the surface features of the tests, we arrive at a few indications of the process by which this peculiar self-contained genus has been developed.

To look at some *Agnosti* (*e. g.* *Regii**) one would hardly suspect that there are more than two lobes in the glabella, but on examining others (*Fallaces* and *Longifrontes*) it will be seen that there has been an abortion of the true posterior lobe (called "basal lobes"), so that in the *Regii* it has become a mere ridge. The so-called posterior lobe of the glabella is also itself in some species seen to be indented by two pairs of furrows; hence there are normally five lobes in the glabella.

The abortion of the true posterior lobes of the glabella (the "basal lobes") is the fixation of an early larval condition in *Agnostus*. This lobe in *Agnostus* never becomes an integral part of the glabella, but consists of two small triangular lobes (sometimes nearly obsolete) below the level of the glabella and connected behind it by a narrow thread-like ridge. The triangular form of these lobes is not embryonic, it shows a larval development up to a certain point; but its subordination to the glabella and its separation from it, is evidence of subsequent arrest of growth.

The suppression of the occipital ring reduces the cephalic somites in *Agnostus* to five, which is the complete number in many trilobites which have this ring. In most species of *Agnostus* the occipital ring is not recognizable, hence the first

*The several sections into which the genus *Agnostus* has been divided by Tullberg are described at page 210

joint of the rachis has no protecting cover, except in so far as the attenuated posterior lobe (basal lobes) of the glabella may assume that office, an unusual condition with trilobites. *A. regulus* is the only species known to me that has an occipital ring.

Agnostus is the sole genus among the early Cambrian trilobites, except *Microdiscus*, in which the pleural groove runs forward in going outward toward the extremity of the pleura, and in association with this we find the point of the pleura in most *Agnosti* turned forward,* this is especially plain in *Longifrontes*. In *Fallaces* the pleural groove on the posterior segment lies along the front of the pleura, but on the anterior segment at the back; hence the pleura in this group is inflated in the middle and tubercle-like; on the anterior segment there are really two grooves, of which the anterior affords an interlocking edge with the marginal fold of the head shield when the body is folded together.

The long pygidium of an *Agnostus* assures us that this part has undergone very considerable changes from the early larval moults, but the proof is not often apparent; an examination of the tests of two species (*A. Acadicus* var. *declivis* and *A. Nathorsti*) give an inkling of the way in which the changes have come about—those which resulted in the three-lobed rachis of the early *Agnosti*.

In *A. Nathorsti* and other *Longifrontes* the attenuated and depressed end of the rachis is the original pygidium, the front of this part is marked by a minute tubercle (to be found only in well preserved tests); in a rare example of the pygidium of *declivis* three pairs of scars behind this tubercle point out the existence of three somites here; two pairs of scars in front of this little tubercle indicate the presence of two more somites, which complete the posterior lobe of the rachis; these two somites swell out to greater width and height than those behind; the anterior of these two somites is also sometimes further marked off by a pair of furrows, one on each side of the rachis corresponding to the oblique furrow on each side of the anterior lobe of the adult rachis; in *Regii* these furrows are so strongly developed that this somite was counted by Barrande as a part of the middle lobe of the rachis. The middle lobe and the anterior lobe of the rachis form another enlarged pair of somites with a tubercle or spine at the back, and correspond to the two front somites of the posterior lobe.

We thus see that by its pygidium *Agnostus* shows three stages

*An exception to this almost universal rule is *A. granulatus* Barr., but it is one of the few *Agnosti* that have genal spines.

NOTE—204 of last line p. 208, should be 210.

TRANSACTIONS N. Y. ACAD. SCI., XV., Sig. 11, August 14, 1896.

of development: 1. The early larval stage—non-agnostiform—when it possessed about 1–3 somites; 2. The later larval stage—agnostiform—when it had about 4–5 somites; 3. The adult condition, when it had about 6–7 somites, and the three main lobes of the rachis were developed with 4–5 somites in the posterior of the three.

The above remarks are based wholly upon the three types of Agnosti that appeared in Europe and America simultaneously in the first sub-fauna of Paradoxides. To us the special features of the other two sections of the genus are of less moment, as they appear to be simply a progressive effacement of those that are found in the earlier types; and it is in accordance with this that they appeared later in time, the Parvifrontes in the third sub-fauna of Paradoxides, the Lævigati scarcely before the fourth, while these latter culminated in the sixth, seeing that the beds are called the zone of *Agnostus lævigatus*.

In these later types of the Paradoxides beds both the glabella and the rachis are effaced, so that scarcely any means remain of distinguishing the heads from the tails in these smooth tests. Nevertheless it is not such aberrant types that carry on the genus Agnostus to a later time, but modifications, more direct, of the primitive types; for though the Regii disappeared from the stage of life in the early Cambrian time, Fallaces and Longifrontes survived in the Ordovician seas, and the former lived on to its close. Thus this type which was the most abundant when the Agnosti appeared in the seas of Sweden, Wales and eastern Canada was the last to disappear when the genus was finally extinguished at the close of Ordovician time.

Tullberg, in his classical memoir on the genus Agnostus,* divides it into four groups, distinguished by well marked and easily recognized characters.† The arrangement is such as to greatly aid in determining the species of this large genus, so characteristic of all parts of the Cambrian from the Olenellus zone upward. The greatest development of the genus is in the Paradoxides zone, and especially the upper part.

The following are Tullberg's sections:

Longifrontes. "Distinguished by a manifest extension of the glabella and rachis, which commonly is rather long. Test sometimes smooth, sometimes the cheeks are furrowed, sometimes the test both on the cheeks and pygidium is studded with elevated points. The marginal fold is generally narrow. The cheeks in

*Om Agnostus arterna i de Cambriska aflägringarne vid Andrarum. S. A. Tullberg, Stockholm, 1880.

†It may also with propriety be divided into five sections as the Limbat contains two very distinct types.

front of the glabella and the side-lobes behind the rachis of the pygidium are divided by an indented line."*

This group, both in Sweden and eastern Canada, was one of the first to appear, and it proved also to be one of the most persistent. The following species and varieties may be referred to it:

Agnostus obtusilobus.

A — *Davidis*, Hicks.

A — *gibbus*, Linrs.

A — — var. *partitus*.

A — — var. *acutirobus*.

A — *Nathorsti*, Brögg. and var. *confluens*, n. var.

A — *fissus*, Lundg., and var. *trifissus*, n. var.

A — *punctuosus*, Ang.

Limbati. Tullberg divides this group into two sections, viz., *Regii*, of which *A. rex*, Barr., is the type, and *Fallaces*, with *P. fallax*, Linrs., as the type. Both sections are old, being found in the earliest *Paradoxides* beds both in Europe and America. This group (*Limbati*) has the following characters: "A shield which is generally more quadrate in form than the *Longifrontes*; the head shield has a broader marginal fold; the basal lobes of the glabella are more prominent; the cheeks in front of the glabella are not separated by a furrow, and they are smooth, and the pygidium commonly has a pair of spines at the back margin."

"The section *Regii* is distinguished by its broad marginal fold, by the reduced cheeks and reduced side lobes of the pygidium; also the glabella, especially at the front part, is broad, and the third joint of the rachis of the pygidium is shortened."

The *Regii* have been found in America in the first and third sub-faunas of the *Paradoxides* zone. Only two species are known.

Agnostus regulus, and

A — *Rex*, Barr., var. *transectus* n. var.

The section *Fallaces* has the following characters: "The head shield is smaller, the marginal fold not so broad, the cheeks are larger, the basal lobes of the glabella rather large, and the third joint of the rachis of the pygidium is the largest."

The following species are found in eastern Canada and Newfoundland:

Agnostus fallax, Linrs., var. *vir*.

A — — var. *concinus*.

A — — var. *trilobatus* n. var.

A — *Acadicus*, Hartt.

A — — var. *declivis*.

* The last character is not constant as regards the pygidium.—G. F. M.

Parvifrontes. "This group is distinguished by the incomplete development of the glabella, which is not divided into lobes."

In eastern America this group appears first with the *Abenacus* sub-fauna, and has the following species:

Agnostus parvifrons.

A ————— var. *tessella*.

A ————— var. *truncatus*.

A ————— *umbo*.

Lævigati. "This group is distinguished by the more or less complete effacement of the glabella and the rachis of the pygidium.* The test is always smooth and shining, sometimes with traces of furrows. The marginal fold has a tendency to disappear from the head shield, but becomes broad on the pygidium."

The group has been found in the *Paradoxides* beds of America, chiefly in those of Newfoundland. It comes in freely with the *Davidis* sub-fauna.

The following species occur:

Agnostus lavigatus, Dalm., var. *terranovicus* n. var.

A ————— var. *ciceroides* n. var.

A ————— var. *mammilla* n. var.

? A ————— *nudus* Beyr.

In describing the following species the author has not followed Tullberg's arrangement entirely, because he has found *Longifrontes* rare in the first sub-fauna, their great development was in the third, fourth and fifth sub-faunas. On the other hand, the *Regii* appear to have been verging towards extinction, as in America they disappear with the advent of the *Abenacus* (third) sub-fauna. The arrangement adopted is *Regii*, *Fallaces*, *Brevifrontes*, *Longifrontes*, *Lævigati*.

The *Agnosti* of the American *Paradoxides* beds have a definite order of succession, corresponding nearly to that observed in those of Europe, viz.:

In the *P. lamellatus* sub-zone are the following: *Regii*. A. *regulus*—*Fallaces*. A. *fallax*, and var. *vir.*, and var. *trilobatus*—*Longifrontes*. A. *gibbus* and var. *partitus*.

In the *P. Etemenicus* sub-zone.—*Fallaces*. A. *fallax* and A. *Acadicus*.

In the *P. Abenacus* sub-zone.—*Regii*. A. *rex* var. *transectus*—*Fallaces*. A. *fallax* var. *concinus*. A. *Acadicus* var. *declivis*—*Parvifrontes*. A. *parvifrons* and var. *tessella* and var. *truncatus* and A. *umbo*—*Longifrontes*. A. *obtusilobus*. A. *gibbus* var. *acutilobus*, A. *Nathorsti* and var. *confluens*, A. *fissus* and var. *3-fissus*.

*This last (the effacement of the rachis) is not a constant feature.

In the P. Davidis sub-zone.—*Fallaces* A. *Acadicus* var. *declivus*—*Parvifrontes*. A. *parvifrons*—*Longifrontes*. A. *Davidis*, A. *fissus*, var. *trifissus*, A. *punctuosus*—*Lævigati*. A. *lævigatus* var. *terranoivus*, var. *ciceroides* and var. *mammilla*, A. *nudus*?

AGNOSTUS REGULUS. (Plate XVI., figs. 1a, b and c.)

Agnostus regulus. Trans. Roy. Soc. Can., vol. iii., pt. iv., p. 67, pl. vii., figs. 1 a-c.

Amended Description.—Body elongate-elliptical, with straight sides and semi-circular ends.

Cephalic shield elongate, semi-elliptical: posterior contour broken by the projecting glabella and narrow occipital ring. Width and length of the head shield nearly equal. Dorsal furrow distinctly but not deeply impressed. Marginal furrow and fold are sharply defined, and the latter diminishes toward the posterior angles of the shield.

Glabella large, consisting of two lobes; the anterior semicircular, wider than the posterior lobe, elevated above the general contour of the surface, and in some examples undulate with broad furrows, spreading from the back of the lobe; posterior lobe flattened-cylindrical, with a broad, faint transverse furrow, one-third from the front, interrupted at the summit of the glabella by a small tubercle, elongated on the line of the axis. Basal lobes obsolete, being merged in the posterior marginal fold. Occipital ring minute, narrowly lenticular, concealed below the projecting obtusely angular end of the glabella. The cheeks are narrowed in the middle, there being a crescent-shaped limb in front of the anterior lobe of the glabella, and a broad rectangular limb on each side of the posterior lobe of the glabella.

The thorax consists of two segments; the anterior subarcuate and marked by five lobes that are bounded by furrows radiating backward; the inner pair of lobes are larger than the outer. The posterior segment of the thorax is unknown.

The pygidium is elliptical, with straight sides, and is truncated in front of the side lobes; it is widest at the anterior angles. The rachis is large, high, obtusely clavate, constricted in the middle, and divided into three lobes; the anterior lobe is narrow, especially in the middle; the middle lobe is short and sublenticular in form and bears an elongated ridge like tubercle on the apical line that projects backward across the anterior segment of the third lobe; the third lobe is subpentagonal in form and has a pair of side furrows in the widest part. The lateral lobes of the pygidium are narrowed opposite the posterior part of the rachis and meet behind it.

Size.—Length, 6 mm.; width, $2\frac{1}{2}$ mm.

Horizon and Locality.—Found in the fine gray shales of Div. 1 c¹ at St. John and at Porter's and Hanford Brook, St. Martin's, N. B., but nowhere plentiful.

This little species is remarkable for the large size of the glabella and the rachis; in these features and in the expanded anterior end of the glabella it resembles *A. rex*, Barr. and *A. regius*, Sjogr., but there are no raised lobes on the cheeks similar to those species, and the proportions of the glabella, etc., differ. It is nearest the latter species.

AGNOSTUS REX, Barr. var. TRANSECTUS n. var. pl., xvi., fig. 2.

This form differs from the type as described and figured by Tullberg in having the first and second segment divided completely; for there is no continuous ridge on the rachis from the front to the middle of the shield, as in the type; but the ridge arises toward the back of the middle lobe, and thence stretches nearly across the anterior segment of the posterior lobe.

It also differs from the type in the proportionately longer rachis, and in the narrowness of the raised area which encloses the end of the rachis; here the rachis almost touches the flattened band which runs around the shield within the margin.

Size.—Length of pygidium, $6\frac{1}{4}$ mm.; width, 6 mm.

Horizon and locality.—Dark gray shales of Div. 1 d¹, at Porter's Brook, St. Martin's. Rare.

AGNOSTUS FALLAX, Linrs. pl. xv., figs. 8a and b. (young)

Agnostus fallax Linrs. Om Vestergot. Cambr. och Silur. aflagr., p. 81, tab. ii., figs. 54, 55.

Agnostus fallax, Brögger, Om Paradoxid. skifr. ved Krekling, Nyt. Mag., Christiania, 1878, p. 64, tab. vi., fig. 1, 1 d.

Agnostus fallax, Linrs. Om faun. i lagr. med Paradox. Øland. Geolog. förenin, Stockholm, 1877, p. 371, pl. 15, fig. 7.

Agnostus fallax, Tullb. Om *Agnostus arterna*, p. 31, pl. ii., fig. 22.

The following is Linnarsson's description of this species:

"Test smooth. Head-shield subquadrate, surrounded by a wide margin glabella bilobed, anterior lobe broad, posterior lobe with an indentation on each side in front of the middle, furnished with an elevated point behind the middle. Basal lobes large triangular. Cheeks confluent in front of the glabella. Pygidium subquadrate, surrounded by a marginal fold which is broader behind and bidentate. Rachis scarcely three-jointed, the first joint with obsolete lateral tubercles, middle joint ornamented with an elevated point."

The *typical* form is described as "Rachis of the pygidium long, nearly reaching the margin, lateral lobes greatly narrowed behind, scarcely meeting behind the rachis, marginal fold moderately broad."

Size.—Length and breadth of the shield, 3-4 mm.

There is so much difference in the tests which are referred to *A. fallax* by Swedish geologists that I am constrained to admit that the form I have described as *A. vir* can be included as a variety under it, and it is here so described; it is in fact nearer the typical form than *A. fallax*, var. *ferox*, Tullb.

Development of the young.—Several small heads and tails of the following variety of this species show important differences from the adult. The head when of the length of $\frac{1}{2}$ mm. shows a narrow, cylindrical glabella, divided into four lobes by furrows indenting the sides; the first furrow crosses, but is shallow in the middle, the second is less distinct, the third is fainter still; the basal lobes cannot be seen. When the head has grown to the length of 1 mm. the anterior furrow alone is distinct, and the glabella is much as in the adult.

The pygidium in the larva of this size (1 mm. long) is proportionately shorter and the rachis more prominent than in the adult, and the marginal fold and cusps are quite distinct; three transverse undulations divide the rachis into four somites; these divisions except remnants of the anterior one disappear in the adult, as does also a minute spine at the back of the third lobe from the front. The embryonic pygidium is indicated by the low and weak part of the rachis behind the small spine visible on this tailpiece.

An example $1\frac{1}{2}$ mm. long of the pygidium of this variety bears four cusps at the posterior border, but this extra armament is rare; it may be compared with var. *tricuspis* found by Brögger in the Paradoxides bed of Krekling, in Norway,* which has a central cusp between the two usually found.

Agnostus similis Hartt, which Walcott makes a synonym of *A. Acadicus* might belong here but for its want of spines on the caudal shield.

Var. *VIR*. pl. xv., fig. 6.

Agnostus vir. Trans. Roy. Soc. Can., vol. iii., pt. iv., p. 69, pl. viii. fig. 3.

? *Agnostus similis*, Hartt, Acad. Geol., 2d ed., p. 606.

This is a larger form than the type, and differs in the more conical glabella, with the spine set further forward, in the com-

* On Paradoxidesskifrene ved Krekling, p. 87, Tab. vi., fig. 1a.

paratively smooth ring of the posterior joint of the thorax, and in the absence of segmentation in the rachis of the pygidium.

Size.—Length, 12 mm; width, 5 mm.

Horizon and locality.—This variety has been found only at St. John in Div. 1 c¹. The typical *fallax* occurred here also, but is more common at Hanford Brook in Div. 1 c².

VAR. CONCINNUS. pl. xv., figs. 7a to c.

Agnostus vir. var. *concinnus*, Trans. Roy. Soc. Can. vol. iii., pt. iv., p. 70, pl. vii., figs. 4a to c.

This form presents the following differences from var. *vir.*: The glabella is more cylindrical, is proportionately longer and the cross-furrow is directly transverse. In the thorax the last segment carries five distinct lobes, the middle lobes being segmented. In the pygidium at the anterior end of the rachis, a small triangular lobe is faintly defined on each side. This variety is smaller than in the type.

Size.—Length, about 9 mm; width, 3½ mm.; cephalic shield, 4 x 3½ mm.

Horizon and Locality.—The fine dark gray shales of Div 1 d¹ at Porter's Brook, St. Martin's, etc.

Development of the Young.—Both the head shield and pygidium of the ½ mm. size have been found in this form. The front furrow of the glabella is more distinct than in the preceding variety, and the basal lobes are scarcely visible. At 1¼ mm. some heads develop a short furrow from each front corner of the glabella, running forward; this furrow is sometimes seen in the adult of *A. fissus*. A head shield 3½ mm. has three furrows of this kind; one median.

The pygidium of ½ mm. size already has the marginal fold and furrow distinct, but the furrow is not widened backward, though the fold is and is cuspidate. The rachis is prominent, except behind, and the front lobe is marked off by a shallow furrow; the width of the second lobe is defined by the long axial tubercle; behind it is a third lobe, not defined by any furrow, weak and at the end sinking below the level of the cheeks, which meet and are wide behind it. In this small pygidium there is no fourth lobe in the rachis, but this is developed in the 1¼ mm. shield, which differs little from that of var. *vir* of the same size, except that the posterior tubercle has not been observed.

VAR. TRILOBATUS. pl. xv., fig. 9.

Agnostus partitus (supposed pygidium). Trans. Roy. Soc. Can. vol. iii., p. 68, pl. vii, fig. 2b.

A head shield associated with this pygidium does not differ from the type of *A. fallax*, but the pygidium does.

Pygidium quadrate, somewhat wider than long, marginal fold and furrow sharply defined in front, wide at the sides and with strong spines. Rachis trilobed by two strong transverse furrows, which are deeply cut in the middle and also at the extremities with a shallower space between; the anterior lobe is narrow with lateral tubercles, middle lobe crossed by a strong keel-like tubercle, posterior lobe having a somite about as wide as the middle lobe, marked off at the front by a shallow furrow, not always distinguishable.

Size.—Length of the caudal shield, about 3 mm.

Horizon and Locality.—Fine grey shales of Div. 1 c.¹. St. John. Scarce.

This pygidium is of considerable interest because it represents in the adult condition a larval phase of *Agnostus*. It is instructive to compare it with the 1 mm. larval form of *A. fallax* (type) (pl. xv., fig. 8b) which shows a similarly, but more ~~imperfectly~~ segmented rachis. This pygidium is the only one of the *Fallax* section which is distinctly segmented; it thus expresses a condition of that shield quite common in the *Longifrontes*, and partly for that reason was at first thought to be the caudal shield of *A. partitus*; the general facies however, is that of a *Fallax*.

AGNOSTUS ACADICUS Hartt. pl. xv., figs. 10a and b.

Agnostus Acadicus Hartt. Acad. Geol. 2d ed. p. 665, fig. 229, U. S. Geol. Surv. Bull. 10 p. 22, pl. ii., figs. 2a, b and c. Trans. Roy. Soc. Can. vol. iii., p. 70, pl. vii., figs. 5a and b.

Head minute, transversely elliptical, or subcircular, breadth and length about equal, convex but very depressed, outlines in front and on the sides slightly straightened. A narrow, flattened and but very slightly elevated border goes round the front and lateral margins. This is separated from the rest of the shield by a narrow, shallow, flat space, or groove, which on going posteriorly along the lateral margins loses gradually in width towards the posterior angles of the shield, which are rounded. Glabella a little less than two-thirds of the length of the shield, long elliptical, depressed convex, but more elevated than other parts of the shield, about twice as long as broad, bounded anteriorly and laterally by a sharp but rather deep groove concentric to the outer one above described. A well marked transverse furrow arching backward separates the anterior third of the glabella as a subcircular lobe. Posterior part of the glabella rounded, but impressed on each side by a little

faintly

lobe situated in the angle between the cheek lobe and the glabella. These little lobes [basal lobes] are about one-quarter of the size of the anterior glabellar lobe; cheeks of the same width throughout, and uniting in front of the glabella, being bounded by the two concentric grooves above mentioned. Posteriorly they are rounded; in width they are rather greater than the glabella. They are convex, more elevated along their inner margin, but sloping outward roundly and evenly. Glabella with its lobes project considerably beyond the posterior margin. Surface smooth.

"Pygidium of this species (?) of about the same outline as the cephalic shield. The posterior and lateral margins have a slight, raised border, separated from the lateral lobes by a shallow but well marked groove, running parallel to the margin. This groove widens at the point where it bends to go forward along the sides in such a way as to encroach on and thin out the marginal fold, and just before reaching the anterior margin it narrows itself from the inner side, so as to cause the lateral lobes to widen somewhat anteriorly. These are narrow, flattened, about half as wide as the middle lobe, narrowing to a point just behind the middle lobe, where they do not unite. The medial lobe is about five-sixths of the length of the pygidium, shield-shaped, flattened, convex, more elevated than the lateral lobe. Its anterior border is slightly concave in the middle. The lateral angles are rounded, and the lobe is contracted a little anteriorly. It is bounded by two deep and well marked furrows, which join one another in the middle of the marginal furrow, forming a pointed arch; median lobe projecting farther forward than the lateral ones. A little spine is situated on its mesial line; about one-fourth of its length from its front, surface smooth."

Mr. Walcott remarks: "After a careful study of all the specimens in the collection, fifteen in number (Hartt's collection at Cornell University), I am unable to make out sufficient difference between the form described as *A. Acadus* and that given as *A. similis*, to establish two species. There is a certain range of variation in the specimens, as pointed out by Mr. Hartt, but that is so variable and owes its origin so largely to the conditions of preservation of the various specimens that it is not evident that the two species are typified."

After examining much larger collections of the Agnosti of Div. 1 c (the horizon of the St. John group from which Prof. Hartt's collections came), than Walcott had under review, I am not altogether satisfied with the above determination, though it appears to be the best solution as to the use of Hartt's names.

It appears strange that while *A. fallax* and its varieties are by far the most common Agnosti of that horizon, Hartt should describe only spineless pygidia; these I find comparatively rare at this horizon, though they become plentiful in Div. 1 *d* (whose fauna Hartt did not have). And then the description of *A. similis* more nearly accords with that of *A. fallax* than does that of *A. Acadicus*.

Size.—Length of each shield, 5 mm.; width, $5\frac{1}{2}$ mm.

Horizon and Locality.—Grey shales of Div. 1 *c* at St. John, Radcliff's stream, etc.

Var. DECLIVIS. pl. xv., figs. 11a to d.

Agnostus Acadicus var. *declivis*, Trans. Roy. Soc., Can. vol. iii., p. 70, pl. viii., figs 6a and b.

This form is closely allied to *A. Acadicus*, but presents the following differences: It has a narrower border fold and smaller basal lobes, the glabella has proportionately a longer anterior lobe, and the furrow dividing it from the posterior lobe is directly transverse; the posterior lobe is strongly elevated, almost tumid behind, and bears a small round tubercle at the middle of its length; in front of the tubercle the lobe slopes down rapidly to the cross-furrow.

Differences of equal import are found to exist between the pygidia of the two forms. In var. *declivis* the rachis is cylindro-conical, and there are three minute lobes on each margin near the anterior end; in *A. Acadicus* the rachis is more triangular in form, and both the head and tail shields are found of a larger size than those of the variety. The marginal fold is not quite even, but is interrupted not quite half-way to the back of the shield by a small, inconspicuous, knob-like spine. A pair of furrows just in front of the tubercle on the glabella, and another pair a little behind it, both directed slightly backward, slightly indent the sides of the glabella.

The thorax, of two joints, has three lobes on the axis of each joint, the mid-lobe being wider, and the side lobes lower on the posterior than on the anterior joint; the pleura have furrows directed forward; that on the hinder joint is placed on the front and that on the interior joint on the back of the pleura.

This variety has the head of a *Fallax* with the tail of a *Brevifrons* (e. g., *A. parvifrons* Linrs.).

Development of the young.—Head shield of $\frac{3}{4}$ mm. long has no visible basal lobes, but otherwise does not differ much from the adult. In a head $1\frac{1}{4}$ mm. long these lobes become visible, but are very narrow and are confluent with the posterior marginal fold.

The pygidium is more remarkable. One of $\frac{3}{4}$ mm. has an oval form; the anterior margin is straight and without fold, marginal fold around the rest of the shield widening backward. Rachis oblancoolate, trilobed by faintly impressed furrows, front lobe narrow, middle lobe wide but not tuberculate, side lobes with two transverse furrows, the posterior about one-third from the front.

In this individual I conjecture that the anterior of the two furrows on the side lobes, will become the anterior marginal furrow of the pygidium, and the posterior a first furrow on the side lobe; the pygidium would then agree with a similar stage of *Microdiscus* as regards these lobes, but not as regards the rachis.

This minute pygidium shows a simpler structure than the adult, which, notwithstanding that the rachis is not segmented, is sometimes so preserved as to show the number of somites in the rachis. Thus the adult caudal shield (see pl. xv., fig. 11d) is sometimes well enough preserved to show on the cast of the inner surface a row of minute tubercles on each side of the rachis (five in number) and two on the axial line; the lateral tubercles are placed on the line between the somites, and each of the axial tubercles in the middle of a somite; it thus appears that the somites are in pairs, one with and the other without an axial tubercle. The first and second somites correspond to the first and second lobes of a *Longifrons* pygidium, and the remainder of the axis to the third lobe in the pygidium of an individual of that section of *Agnostus*. Also we observe that while in the first larval stage there are only three somites recognizable in the pygidium, the adult caudal shield has six.

Agnostus declivis may be compared with the later *A. secretus* Walc., of the Prospect Mountain group, which it resembles in general form as well as in having the glabella tumid behind. Neither this variety nor the type of *A. Acadicus* appears to have any very near allies among the species of the *Paradoxides* beds of Sweden, known to the author.

Size—Length, about 7 mm. Width, 3 mm. Cephalic shield 8 x 3 mm.

Horizon and Locality.—Abundant in the fine, dark shales of Div. 1 d¹ at Porter's Brook, St. Martin's.

AGNOSTUS PARVIFRONS Linnarsson.

Agnostus parvifrons Linnarss. Om. Vestergötland Cambr. o. Silur. aflagr., p. 82, tabl. 2, fig. 56, 57.

Agnostus parvifrons Tullb. Om. *Agnostus-arterna*, p. 34, tabl. ii., figs. 26, 27, 28.

Test smooth. Head-shield enclosed by a marginal fold that is broader in front. Glabella small, round, not lobed. Basal lobes small. Cheeks expanded, connected in front of the glabella; pygidium without spines; marginal fold wider behind; rachis long, almost reaching the border; lobes sometimes obsolete, sometimes apparent; middle joint ornamented with an elevated point; lateral lobes narrowed behind, scarcely contiguous.

Size.—Length and breadth of each shield, $3\frac{1}{2}$ – $4\frac{1}{2}$ mm.

Horizon and Locality.—Dark gray shales of Div. 1 d¹ at Porter's Brook, St. Martin's, etc.

Mr. C. D. Walcott has described a species of *Agnostus* of the *parvifrons* type found in the Lower Cambrian rocks of Washington County, N. Y. Being claimed as a Lower Cambrian (*i. e.*, Olenellus Zone) fossil, it is not figured here. The glabella is longer than in *A. parvifrons*. It may be remarked, however, that this type of *Agnostus* is not found elsewhere lower down than the *P. Abenacus* (= *tessini*) sub-zone.

A common variety in Canada is the following:

Var ³TESSELLA. pl. xvi., figs. ^aa to c.

Agnostus tessella. Trans. Roy. Soc. Can. vol. iii., pt. iv., p. 71. pl. vii., figs. 7a to c.

This is a transitional form to the Limbati (Fallaces). It differs from the type in having an anterior lobe to the glabella faintly defined; this has no furrow like the posterior lobe, but is marked out by a faint thread-like line on the surface of the test. The posterior lobe is intermediate in length between the two glabellas of *A. parvifrons* figured by Tullberg, but rectangular in front. The pygidium is similar to fig. 27b of Tullberg's plate, but the tubercle is elongated, not round as in that form; the rachis is wider, and its middle lobe proportionately shorter. The marginal fold does not have so great a width behind.

Size.—Length and width of the shields each 3 mm.

Horizon and Locality.—Same as the preceding.

Development of the Young.—A head shield $\frac{1}{2}$ mm. long is narrow, marginal fold and furrow distinct. Glabella long, front furrow distinct, two others faintly marked by depressions crossing the glabella; basal lobes very narrow, scarcely visible.*

A head $1\frac{1}{2}$ mm. has nearly the form of the adult, slight furrows at the anterior corners of the glabella as in *A. fissus* var.

* This is in accordance with the changes of this lobe in the Ptychoparidae in which during the first larval stages this somite is very narrow and weak.

trifissus. A head $3\frac{1}{2}$ mm. shows three fore-furrows of the glabella as *A. trifissus*, but no axial furrow of the glabella.

A pygidium $\frac{1}{2}$ mm. long, is wide, subquadrate, marginal furrow distinct, not widened; fold widened, cuspidate, rachis prominent, front lobe divided off by a shallow furrow, second lobe defined only by the axial tubercle, third lobe not defined, weak, rapidly descending below the cheek lobes, which are wide behind the rachis. A pygidium $1\frac{1}{2}$ mm. long, is quadrate; the third lobe from the front is defined, but the little tubercle is absent. Another common variety is the following:

Var. TRUNCATUS n. var.?

? *Agnostus truncatus* Brögg. Om. Paradoxides skifrene ved Krekling, p. 72, tab. vi., fig. 8.

Brögger's figure, except that it is somewhat more quadrate and larger, is not distinguishable from a common variety of *A. parvifrons* that occurs in the St. John group. The variety found here does not differ from var. *tessella*, except that the front lobe of the glabella is entirely suppressed, and that the individuals are found of larger size.

Size.—Length and width of each shield, 4 mm.

Horizon and Locality.—As the preceding.

Considering these varying forms, we are impressed with the justice of Tullberg's remark that this is a variable species. In *Agnostus Acadicus* of Hartt we may perhaps have an ancestral form of this species; that occurs in the sub-zone of Paradoxides Eteminicus; then in the sub-zone of P. Abenacus we find three other forms, var. *declivis* of *A. Acadicus*, in which the front lobe begins to be depressed, var. *tessella* of *A. parvifrons*, in which the front lobe is traced out on the surface of the head-shield only by an impressed line, and not by furrows, and var. *truncatus*, in which the front lobe entirely disappears; finally, one may add the typical form of *A. parvifrons*, in which any suggestion of an anterior lobe is removed by the rounding of the front of the glabella. It will be noted that there is a resemblance in the pygidia of all these forms, and that *A. Acadicus* differs from the typical Fallaces in the absence of marginal spines to the pygidium, a feature which it possesses in common with all *parvifrontes*.

AGNOSTUS UMBO, pl. xvi., figs. 4a and b.

Agnostus umbo. Trans. Roy. Soc. Can. vol. iii., pt. iv., p. 71, pl. vii., figs. 8a and b.

Body elliptical, broader in front than behind, high at the inner side of the head and tail shields, descending thence to the front

and back. Cephalic shield broadly-transversely elliptical, high and contracted behind, sloping from the glabella in all directions. Marginal fold and furrow strongly marked. Dorsal furrow deep. Glabella suborbicular, rounded in front and behind, bearing a small tubercle on the axial line, one-third from the front; the width of the glabella is more than a third of that of the shield, and its length nearly half. The thorax is unknown. The pygidium is semi-elliptical, with rounded anterior corners; the width is nearly a quarter greater than the length. Both dorsal and marginal furrows are deeply impressed. The rachis is conical and is greatly elevated above the rest of the shield; it is slightly constricted near the anterior end, and about one-third from the front bears a small tubercle. The lateral lobes of the pygidium are rounded in at the anterior end by the rapid curve of the marginal furrow; and at the posterior end are gradually narrowed and are separated at that end by a furrow which connects the dorsal and marginal furrows. The marginal fold is rather wide at the extremity of the pygidium, and is rounded at the anterior corners.

This species is distinguished from *A. tessella* by the entire absence of the anterior lobe of the glabella, and by the round and prominent posterior lobe, having a small tubercle in advance of the middle of the lobe. The pygidium has a shorter, higher and more conical rachis, and the tubercle on it is round, not elongated as in *A. tessella*.

The head shield of *A. parvifrons* var. *mammillata* Brögg resembles that of this species, but is longer; the rachis also of the pygidium is more cylindrical and its tubercle further back in Bröggers' variety.

Size.—Length, 6 mm. ? width, 3 mm.

Horizon and Locality.—In the fine dark shales of Div. 1 d¹, Porter's Brook, St. Martin's. First collected by Dr. L. W. Bailey.

The following species are classed as *Longifrontes*, although, from the absence of axial furrows, the one which is here first described might seem to be not properly placed there; but the thin, flexible test, the large basal lobes and the attenuated and segmented rachis seem to point to this as the proper place for *Agnostus obtusilobus*, the largest species found in the St. John group.

AGNOSTUS OBTUSILOBUS, pl. xvi., fig. 5.

Agnostus obtusilobus. Trans. Roy. Soc. Can., vol. iii., pt. iv., p. 72, pl. vii., fig. 9.

Amended Description.—Body elliptical oblong. Cephalic

shield semi-elliptical, about one-quarter wider than long. Dorsal furrow faintly impressed. Marginal fold and furrow strongly marked. Glabella elliptical-elongate, wider behind, rounded in front, in its widest part nearly a third of the width of the shield; narrowed at the base by two triangular lobes; a semi-elliptical lobe at the anterior end more than one-third of the length of the glabella. Occipital ring and posterior marginal fold narrow. Cheeks continuous in front of the glabella. Thorax of two segments; the anterior segment has five lobes, of which the outer pair are globose and the inner pair subtriangular and widest in front; the center lobe is semi-circular, broad behind, and bears an elongate traverse tubercle in the middle. The posterior segment has three lobes, of which each of the two lateral ones is globose, and bears minute tubercles; the central lobe is subrectangular elongate, and the middle half is traversed by an arched furrow, which begins and terminates on the posterior margin of the segment. The pygidium is semi-elliptical, about one-sixth wider than long, and has the anterior margin arched forward. The marginal fold and furrow are about as distinct as those of the head shield. The rachis is ob lanceolate, constricted in the middle, clavate, and pointed behind, about one-third longer than wide; it is traversed by two furrows, of which the one near the anterior end arches forward, and the other, near the middle of the rachis, arches backward. At the broadest part of the axial lobe there is transverse depression. The first segment of the rachis is narrow and elevated transversely; the second segment is elevated lengthwise, having an elongated tubercle at the axial line that projects backward on the third segment; the third segment is triangular and depressed across the middle, and bears a small axial tubercle on the anterior third.

Sculpture.—The surface of the test in this species has a velvety appearance, and under the lens is seen to be covered with minute granulations, the surface also is rugulose or uneven, and the test thin and more apt to be distorted than those of the two preceding species. The parts of the body in this and the following *Longifrontes* are more frequently found connected than are those of the preceding species; and while in the species above described the two shields are often found doubled together, in this and the following species they are frequently spread at length. This species resembles *A. scarabeoides* of the Welsh Cambrian rocks, but has a narrower glabella with a more obtuse front.

Length, 11 mm. Width, 6 mm.

Horizon and Locality.—In the fine dark grey shales of Div. 1 d¹, at Porter's Brook, St. Martin's. Infrequent.

The pygidium of this species may be distinguished from that of *A. acutilobus* in the fact that the tubercle of the second joint encroaches so decidedly on the third joint as to make a strong sinus in the dividing furrow; also it may be distinguished by the proportionately shorter third joint of the pygidium. This species appears to have no lateral spines to the pygidium.

AGNOSTUS DAVIDIS, Hicks. Plate xvi., fig. 6.

Agnostus Davidis, Hicks. Undescribed fossils of the Menevian group. Jour. Geol. Soc. London, 1872, p. 173, pl. v., figs. 2 to 4.

A large pygidium, about the size of that of Hicks' species above named, occurs at Manuel Brook. It is flattened in the shale and so its contour is not known. Dr. Hicks' examples appear to have been distorted by pressure; allowing for this our example agrees fairly well with the pygidia he figures; his description of the species is as follows:

"Head rounded and forming about two-thirds of a circle, and about $\frac{3}{4}$ of an inch long, surrounded by a narrow border. The glabella occupies about one-third of the width, and tapers forward. It is divided at the base of the anterior third, by a transverse furrow, into an anterior spheroidal lobe and a posterior elongated lobe, the anterior part of which is raised centrally; there is a triangular lobe on either side at the base of the glabella. Cheeks slightly raised and gibbous.

Thorax depressed, strongly trilobed; pleurae grooved deeply to the tips. Axis trilobed, the central lobe being largest and pyramidal in shape. The two lateral lobes triangular in shape.

Tail of the same shape as the head, but more strongly margined. The axis is large and occupies more than a third of the width, reaches backwards to within a short space of the posterior margin and is indented by three furrows on each side, each running obliquely backwards from the centre, which is somewhat raised.

This is the largest species found in the Menevian group. Found at St. David's and near Dolgelly, North Wales."

In the American examples I cannot recognize the third furrow of the axis of the pygidium mentioned and figured by Dr. Hicks, and on the other hand he does not describe a low tubercle which is found on the second lobe of the pygidium in this American form.

Sculpture. The axis and side lobes are covered with minute

tubercles, only visible with a lens. Size of this caudal shield, length and breadth each 9 mm.

Horizon and Locality. Grey shales of the *P. Davidis* Zone at Manuel Brook, Conception Bay, Newfoundland.

This species is distinguished from *A. scarabeoides*, Hicks, by the absence of visible tubercles on the surface of the test.

AGNOSTUS GIBBUS, Linnarsson.

Agnostus gibbus, Linrs. Om Vestergot. Cambr. Silur. Aflagr. p. 81, tab. ii., figs. 52, 53.

Agnostus gibbus, Broegg. Om Paradox, lagr. v. Krekling, tab. vi., fig. 11.

Agnostus gibbus, Linrs. Om faun. i Kalk. m. Conocoryphe exsulens, p. 22, tafl. ii. figs. 31, 32.

Agnostus gibbus, Tullb. Om Agnostus-arterna, p. 15, tafl. i., fig. 2, a and b.

The following is the diagnosis of this species: "Test smooth. Head surrounded by a narrow subfiliform border. Glabella 2-lobed, anterior lobe rounded-subtriangular, equalling the posterior lobe in width, posterior lobe elevated into a tubercle, often very tumid, in the anterior part of which tubercle an elevated point can sometimes be seen. Basal lobes small, entire, rounded triangular, connecting behind the above tubercle by a narrow rim. Cheeks without lateral grooves, separated in front of the glabella by an impressed line. Pygidium rounded, without spines, and having a narrow border fold. Rachis 3-jointed, the anterior joint divided into three parts by two longitudinal depressions, of which the middle is the smallest; the middle joint narrower than the others, but much higher, produced backward into a rather long, free denticle which almost always is broken off; the posterior lobe large, convex, rounded-acuminate behind. Lateral lobes narrowed behind, separated by an impressed line."

Horizon and Locality.—Grey shale of Div. 1 c. 1. St. John, N.B. Canada. Scarce.

Size.—Length and width of the shields, 5 mm.

Tullberg says the name is derived from the projecting spine on the rachis of pygidium, "directed backward and upward" [but the back of the glabella is said to be very tumid ("tumidissimum")].

The varieties and forms included under this species by Swedish geologists allow one to consider it a flexible species, liable to considerable change of form. It is thus capable of including two forms which we have described in the Transactions of the Royal Society of Canada as separate species; there is the more

reason for this since we have discovered that the pygidium referred provisionally to one of these forms (*A. partitus*) is of a different type from the usual pygidium of a *Longifrontes*, and therefore should be referred elsewhere; we have consequently included under this species, *A. partitus* and *A. acutilobus*.

Var. PARTITUS. Plate xvi., fig. 7.

Agnostus partitus. Trans. Roy. Soc. Can., vol. iii., pt. iv., p. 68, pl. viii., fig. 2a (not 2b).

Cephalic shield elongate semi-elliptical. Dorsal furrow distinctly impressed; marginal fold sharp and narrow. Glabella cylindro-conical, obtusely pointed in front, expanded at the base; anterior lobe obtusely pointed, less than a third of the glabella's whole length; posterior lobe strongly elevated and obtusely pointed behind; basal lobes triangular, depressed to the level of the cheeks. Cheeks somewhat narrower in front than at the sides; divided in front by a distinct furrow that connects the dorsal and marginal furrows.

The heads of this variety are hardly distinguishable in form from the next, but they are all small, and it is found with an older subfauna; it is therefore kept separate. The pygidium is unknown.

Size.—Length and width of the head shield $2\frac{1}{2}$ mm.

Horizon and Locality.—The grey shales of Div. 1 c, ¹, at Porter's Brook and Hanford Brook, St. Martins, N. B., Canada. Infrequent.

Var. ACUTILOBUS. Plate xvi., fig. 8.

Agnostus acutilobus, Trans. Roy. Soc. Can., vol. iii., pt. iv., p. 73, pl. vii., fig. 10.

Body elliptical elongate. Cephalic shield semi-elliptical, somewhat longer than wide. Dorsal furrow lightly impressed. Marginal furrow and fold sharply defined. Glabella subconical, widest behind, obtusely pointed in front; at the widest part of the posterior lobe it is one-third of the width of the head shield, and its length is about three-fourths of that of the head shield; the glabella is divided into four lobes, of which the anterior is one-third of its length and is subtriangular; the posterior lobe extends to the base of the shield. It bears an elongated ridge on the anterior half, where it is higher than it is behind; two faintly marked lateral furrows are just discernible on the lateral edges of this lobe. The two basal lobes of the glabella are comparatively large; they are divided from the rest of the glabella by a sigmoid furrow, and are depressed below the level of the

glabella. The occipital ring is narrow, and is concealed beneath the projecting posterior extremity of the glabella. The cheeks are somewhat full, especially in front, and are divided by a furrow that connects the dorsal and marginal furrows, and each cheek is seamed across by a fainter furrow.

The thorax consists of two segments, of which the first bears five lobes; the two outer pairs of these lobes are globose, and the central one is semicircular and is crossed in the middle by a light furrow transverse to the axis of the thorax. The second segment of the thorax has three lobes, of which the two outer are somewhat elongate, and each is marked by a light furrow; the central lobe is subrectangular, and is traversed by a furrow angulated on each side of the axis of the thorax, and beginning and terminating on the posterior side of the lobe.

The pygidium is subelliptical, and its width and length are about equal. The marginal fold and furrow are about as distinct as those of the head shield. The rachis is ob lanceolate, nearly half as wide as the pygidium, and its length is about four-fifths of that of the pygidium; it is narrowed in the anterior third, and is crossed in that part by two transverse furrows similar in appearance and direction to those of the preceding variety. The included lobe bears an elongated tubercle; the posterior lobe of the rachis is conical. The lateral lobes of the pygidium are moderately elevated and meet behind the rachis.

Sculpture.—This variety appears to be smooth externally, but sometimes shows a granulated inner surface to the test; by its smoothness it is distinguished from the other *Longifrontes* that occur with it.

Size.—Length, 13 mm. Width, 5 mm.

Horizon and Locality.—Frequent in the fine dark shales of Div. 1 d, ¹. At Porter's Brook, St. Martin's, N. B.

This variety differs from the type of *A. gibbus* in its narrower rachis and the peculiar second lobe of the pygidium. It is the most widely diffused of the *Longifrontes* in the St. John group.

? Var.

A few pygidia which by their general form, and in the lobation and contour of the rachis, appear to be of this species are found with the above form, but they are spined on the margins. We do not know the head shield.

Dr. Henry Hicks' description of *A. scutalis* of the Menevian group in Wales agrees closely with that of *A. gibbus*, except that the cheeks of the head-shields, and the side lobes of the caudal shield are said to be covered with tubercles. This ex-

cludes Hicks' species from *A. gibbus*, but not from *A. punctuosus* which is thus ornamented; the latter species, however, has confluent side-lobes to the caudal shield, while in *A. scutalis* these lobes are divided by a furrow. *A. Nathorsti* is another species that is tuberculate on the sides, and is also nearer the size of *A. scutalis*, but this species has the sides of the posterior lobe of the glabella furrowed, and has marginal spines to the pygidium, characters which are absent from *A. scutalis*; so we find ourselves unable to recognize Hicks' species in the *P. Davidis* subfauna of America.*

AGNOSTUS NATHORSTI, Broegg.

Agnostus Nathorsti, Broegg. Om Paradoxides ~~skifrene~~ ved Krekling, p. 68, pl. v., fig. 1.

Agnostus exsculptus, Ang. part (i. e., "pygidium") Palæontologia Scandinavica, p. 7, pl. vi., fig. 8 (Fide Tullberg).

Agnostus Nathorsti, Tullberg. *Agnostus Arterna* vid Andrarum, p. 21, pl. i., fig. 9.

"Head rounded, enclosed by a subfiliform narrow marginal fold. Glabella bilobate, anterior lobe narrower than the posterior, oblong, equally rounded-acuminate. Posterior lobe almost equal in length to one-half of the head, impressed by two deep grooves on each side, rounded behind, pressed together and high, furnished with a raised point; basal lobes separated from the glabella by a posterior furrow, rounded, connected behind the glabella. Cheeks separated in front of the glabella, sculptured with longer or shorter lateral furrows."

"The rachis of the thorax has elliptical lateral tubercles. Pygidium rounded behind, furnished with a somewhat broader bidenticulate marginal fold. Rachis with three joints, pointed behind, front joint shorter than the others, slightly wider, divided into three parts by two longitudinal depressions; the middle joint keeled, produced backward into a point. Posterior joint rather long, ~~squeezed~~ in the middle part by an arched depression, ornamented with a small elevated point in the depression. Lateral lobes minutely granulated, narrowed behind, separated behind the rachis."

Size.—"Length and width of the shields, $4\frac{1}{2}$ mm."

Horizon and Locality.—Dark shales of Div. 1d¹. Porter's Brook, St. Martin's N. B., Canada, scarce.

Tullberg remarks in his work cited above, that the shield figured by Angelin as the pygidium of *Agnostus exsculptus* is really the head shield of this species (*A. Nathorsti*).

*Figures 13, 14, pl. v., referred to *A. scutalis* are not of this species, but represent some species of the Limbati section (a Fallax).

flattened

Some examples from the St. John group have the axis of the pygidium long and a furrow behind, connecting the dorsal and marginal furrow; these agree more nearly with the European form. The following form, however, is more plentiful.

Var. CONFLUENS n. var. Plate xvi., fig. 9, *a* and *b*.

This form is found in the eastern part of the St. John Basin. It does not quite agree with Broegger's species, but differs in the following respects:

The head shield is less quadrate behind, the furrows on the sides of the posterior lobe of the glabella less undulate, the basal lobes longer. The pygidium is more quadrate, the posterior margin less arched, the posterior lobe of the rachis is shorter and wider than in the type, and the side lobes are not separated behind the rachis by a furrow.

Sculpture.—The surface of the test especially in the head shield is radially wrinkled.

Size.—Length and width of each shield, about 4 mm.

Horizon and Locality.—Dark gray shales of Div. 1 *d*¹, at Porter's Brook, St. John county, N. B.

AGNOSTUS FISSUS, Lundgren.

Agnostus fissus, Linrs. Om fauna i Kalken med Conoc. exsulens, p. 23, tafl. ii., fig. 34.

Agnostus fissus, Tulib. *Agnostus arterna* vid. Andrarum, p. 16, tafl. i., fig. 3, *a* to *d*.

"Head and pygidium shorter and wider [than *A. gibbus*]. Test scarcely smooth, uneven, marginal fold narrow. Glabella shorter, broader, bilobed. Anterior lobe no longer than wide, more or less blunt in front, cleft in front by a very delicate line, equal to the posterior lobe in width; posterior lobe short for its width, one depression visible on each side, reaching its greatest height a little in front of the middle of this part, where an elevated point can be seen. Basal lobes small, triangular, scarcely connecting behind the glabella. Cheeks separated by an obsolete furrow in front of the forehead, ornamented on each side by obsolete furrows."

"Pygidium short, round, without spines. Rachis with three joints, more acuminate than in the preceding, all the joints of almost the same width; lateral parts of the anterior joint thickened; middle joints slightly narrower than the rest, higher, keeled, ornamented with a point. In front of the middle of the posterior joint are two lateral obsolete depressions, between which an elevated point can be seen. Lateral lobes are connected behind the rachis."

Size.—“Length and width of the shields, $3\frac{1}{2}$ mm.

Horizon and Locality.—Fine dark shales of Div. 1 d^1 (the highest layers) at Porter's Brook, St. Martin's.

The Latin description contains no reference to the thorax; this is described in the next paragraph (Swedish). “First joint of the thorax somewhat smaller than the second, rachis with two tubercles at the sides; the pleuræ of the first joint are divided into a larger front tubercle and a smaller back tubercle by a furrow; the tubercles on the pleuræ of the posterior joint are of about the same size.

Var. TRIFISSUS n. var. Plate xvi., fig. 10.

This is about the same size as the type, and is distinguished by two additional furrows at the front of glabella, one at each corner, beside the median furrow that characterizes the type; these furrows cut into the cheeks in front of the glabella; the median furrow is the longest, but none connect with the anterior marginal furrow (or the median one, rarely). There are two minute tubercles at the axial line of the first lobe of the rachis of the pygidium.

Horizon and Locality.—In the Davidis Subzone at Chapel Arm, Trinity Bay, Newfoundland. Also in the Abenacus Subzone (Div. 1 d^1) at Porter's Brook, St. Martin's, N. B.

Development of the Young.—At the $\frac{1}{2}$ mm. stage ($1\frac{1}{4}$ mm. for the complete animal) the head shield already shows the cleft fore-lobe of the glabella, and a shallow indentation across the glabella marking off the first somite of the posterior lobe; the basal lobes are scarcely yet visible. The thorax has only one joint; this joint has tubercles on the sides of the rachis and a furrow on the pleura running directly outward; no pleural tubercles. The rachis of the pygidium is not lobed, but the somites are indicated by the incipient keel of the second lobe, and a very minute tubercle near the front of the third lobe, indicating the third somite; at the front of the rachis is a strong transverse ridge, the “half joint” (articulating ridge) more prominent now than in later stages. The first somite of the pygidium is not yet visible, but it is separated in the $1\frac{1}{4}$ mm. stage ($2\frac{1}{4}$ mm. for the whole animal), when the rachis divides into three lobes. Only one joint of the thorax of this stage has been seen; it shows tubercles on the pleuræ as well as on the rachis. When the animal becomes 3 to $3\frac{1}{4}$ mm. long both joints appear in the thorax and the general features of the test are those of the adult; the basal lobes of the head shield are still very small.

These features of growth in *A. fissus* are based on examples

from the *Abenacus* Subzone of the St. John group. It will be seen that from the earliest stages described, this species can be separated from others, and before the rachis of the pygidium is segmented, the minute tubercle on the third somite distinguishes the species from *A. Nathorsti*, which has this tubercle on the fourth somite: in the young of *A. fallax* it is on the third somite, as in *A. fissus*, but becomes obsolete at a later stage in the former species.

Both the above variety and the type of *A. fissus* have been found at Porter's Brook, but only the variety at Chapel Arm. At Porter's Brook the species is known only from the highest fossiliferous beds of Division 1 *d*; so perhaps did not come to America with the first migrants of the *Abenacus* Sub-fauna.

AGNOSTUS PUNCTUOSUS, Angelin. Plate xvi., fig. 11.

Agnostus punctuosus, Ang. Paleontolog. Scand., p. 8, tab vi., fig. 11.

Agnostus punctuosus, Broegg. Om Paradox'ski fr. v. Krekling, p. 67, tab. vi., fig. 12 *a* and *b*.

Agnostus punctuosus, Tullb. *Agnostus arterna*, p. 17, tab. i., fig. 5 *a* to *d*.

Angelin's description of this species is very brief, the following is Tullberg's:

"Test of both shields granulated. Marginal fold narrow. Glabella bilobate. Anterior lobe narrower than the posterior, subtriangular, divided lengthwise by a fine line sometimes scarcely visible. Posterior lobe ornamented on each side in front of the middle by a depression, and between these depressions by an elevated point, furnished behind the middle of the basal lobes with higher tubercles resting on lateral depressions, rounded behind. Basal lobes elongate, triangular, divided into two tubercles by a lateral depression, uniting behind the glabella. Cheeks separated in front of the glabella, furnished with lateral furrows not deep, slightly undulate, and with small points. Thorax with two joints, rachis ornamented with contiguous lateral tubercles, pleuræ divided into two tubercles by a transverse line.

"Pygidium without spines. Rachis three-jointed; anterior joint shorter and broader than the others; middle joint higher than the others, hexagonal, keeled, adorned with an elevated point; posterior joint elongated, round-acuminate, sometimes bordered by straight lines so as to become quite pointed; often furnished at the middle with a minute point, and below it lateral depressions. In the adult the lateral lobes connect behind the rachis, in the young state they are separated by a fine line; the

lobes are densely granulated. In one pygidium the first joint [of the rachis] has two lateral elevated points, the middle joint near the strongly elevated carina has a point on each side, and the last joint is ornamented with an elevated point on each side in front, and one median point."

Size.—Length and width of the shield 6 mm.

Horizon and Locality.—In America this species is found at Highland Cove, Trinity Bay in company with *P. Davidis*, etc.

This fine species is easily recognized by its tuberculate side lobes and smooth rachis, and corresponding conditions in the head-shield. The somites in the third lobe of the rachis are clearly distinguishable in the American, as in the Norwegian examples, and the paired somites in this lobe are parallel to those seen in *A. Nathorsti*, etc.

AGNOSTUS LÆVIGATUS, Dalman.

Battus lævigatus, Dalm. Vetensk. Skad. Årsber. p. 136.

Battus lævigatus, Hisinger. Lethea Svec., p. 30, tab. iv., fig. 7.

Agnostus lævigatus, Ang. Pal. Scand., p. 6., tab. vi., fig. 3.

Agnostus lævigatus, Broegg, Om/Paradox. skifren. p. 74, tab. v., fig. 6, and tab. vi., fig. 5.

Agnostus lævigatus, Tullb. Om/Agnostus-afterna, p. 27, tab. ii., fig. 17 a and b.

The following is Tullberg's description of this species: "Crust usually very smooth and handsome. Head-shield elongate-rounded, encircled by a narrow filiform marginal fold. Glabella obsolete in front, enclosed by impressed lines behind, rounded behind and ornamented with an elevated point. Basal lobes rounded, connected behind the glabella. Lateral furrows sometimes indent the cheeks. Pygidium elongate rounded, enclosed by a marginal fold which is broader behind. Rachis vanishing backward, the first joint obsoletely three parted, the second ornamented with an elevated point, the third narrow, scarcely distinguishable."

Size.—Length of the shields, 5 mm.; width, 4 mm.

Horizon and Locality.—Head shields of this species occur in limestones at Chapel Arm, Trinity Bay, Newfoundland. As we have no pygidium they may be of the following variety.

VAR. TERRANOVICUS n. var. Plate xvii., figs. 1 a and b.

This variety has the narrow marginal fold of the typical form, but differs in the larger basal lobes of the glabella, and in having the rachis of the pygidium defined throughout by a distinct furrow. In this respect it approaches more nearly the variety

forfax of Broegger, which also has the pygidial axis thus defined; but this axis in the Norwegian variety is longer and is not divided into lobes. In var. *terranovicus* the front lobe of the pygidium is separated by a furrow from the rest of the rachis, but there is no middle lobe except in so far as it is indicated by a tubercle about one-third from the front. The side lobes of the pygidium are wider than in var. *forfax*.

Sculpture.—The test is minutely punctate.

Size.—Length and breadth of each shield, 5 mm. Rachis of pygidium, 4 mm. long, 2 mm. wide.

Horizon and Locality.—Dark siliceous slate of Highland Cove, Trinity Bay, Newfoundland, with *P. Davidis*.

Var. *CICEROIDES* n. var. Plate xvii., fig. 3 a and b.

This is a smaller and more tumid form than the preceding, and the rachis of the pygidium is wider in proportion; the middle lobe of the rachis is marked off from the posterior by a faintly impressed line, and bears a more prominent tubercle than the preceding variety.

Sculpture.—As the preceding.

Size.—Length and width of each shield, $3\frac{1}{2}$ mm. Rachis of pygidium, $2\frac{1}{2}$ mm. long, $1\frac{1}{2}$ mm. wide.

Horizon and Locality.—Found with the preceding.

The head shield of this variety is like that of *A. Cicer*, Tullberg, but it is furnished with a marginal fold; that species also has a wider and only partially defined rachis to the pygidium.

Var. *MAMILLA*, n. var. Plate xvii., figs. 3 a and b.

Nearly the same size as the preceding. It has more distinct basal lobes, but the difference is chiefly in the pygidium; the rachis is undivided and greatly elevated at the second somite where there is a prominent tubercle one-third from the front of the rachis; the lateral lobes are divided by a furrow, and the posterior marginal fold is wide.

Sculpture.—As the preceding, but with small scattered tubercles on the head shield.

Size.—Length and breadth of the shields, nearly 4 mm. Rachis of the pygidium: length, $2\frac{1}{2}$ mm.; width, $1\frac{1}{2}$ mm.

Horizon and Locality.—Found with the preceding.

While the head of this variety is that of a *Lævigatus*, the pygidium is nearly that of a *Parvifrons*; in the latter, however, the dorsal and marginal furrows of the pygidium are confluent, in this variety they are distinct, but connected by a cross-furrow. But for the absence of glabella this variety would closely resemble Broegger's var. *mamillatus* of *A. parvifrons*.

In *Agnostus Barrandei*, Salter, of the Menevian horizon in Wales we evidently have a species of the *Lævigati* section, and although Dr. Hicks' figure* does not show any rim, the description indicates that there was one; from this and the pygidial features this species appears to be allied to *A. lævigatus*, rather than *A. nudus*; but judging from these features, also the two individuals figured must at least be of different varieties; Fig. 5, if we be guided by the form of the rachis, approaches var. *forfax*, and Fig. 6 var. *terrannovicus*; the resemblance does not establish an identity in either case.

? *AGNOSTUS NUDUS*, Beyrich.

This species appears to be indicated by some head shields found in Newfoundland. The head shield is high at the back in the middle and arched down in all directions, and is devoid of marginal fold.

Sculpture.—Smooth and shining with a minutely punctate surface.

Size.—Length and width, 3 mm.

Horizon and Locality.—Limestone of Chapel Arm, Trinity Bay, Newfoundland.

MICRODISCUS, Emmons.

This genus, which in the small number of the pleural joints, is almost on a par with *Agnostus*—for the number varies from two to four for the different species—is characterized by certain changes of form from its earliest appearance until it died out in the later stages of the *Paradoxides* beds—changes which are comparable to those in *Agnostus*, but on different lines: one of these lines of development is the obliteration of the costæ on the side lobes of the pygidium, and the other the extraordinary development of the occipital spine.

The "great nuchal spine" as Salter calls it is not merely an extension of the summit of the occipital ring, but in some species at least it carries with it the posterior part of the glabella; hence these species have no proper occipital furrow, but the two outer ends of this furrow are seen to run a little way up the side of the spine or form a threadlike band at the back of the spine; in such cases the main furrow seen at the base of the spine is in reality the posterior glabellar furrow, and this lighter furrow behind is the occipital furrow.

The obliteration of the occipital furrow in many species of this genus leaves one less than the normal number of furrows on the axis of the head shield, so that usually not more than three,

* *Quart. Jour. Geol. Soc.*, London, May '72, p. 176, pl. V., Figs. 5 and 6.

sometimes only two, can be discerned. All the furrows are usually indistinct or even obliterated in the later species of the Paradoxides Beds, in the adult shields; but even in these there are often impressions of these furrows on the inner surface of the test.

It is in the species of the Olenellus Zone that the series of furrows marking the somites is most clearly seen. *M. speciosus* for instance has three pairs of broadly, but distinctly impressed furrows on the sides of the glabella and also a pair of sharply cut occipital furrows.* In *M. lobatus* the furrows of the glabella are not quite so obvious, and the posterior of the three is usually very indistinct, but the number is the same as in the preceding species.

Both Agnostus and Microdiscus exhibit larval characters in the anterior lobe of the glabella, the former by the large size of the anterior lobe (as in Regii) or its distinctness (as in Fallices and Longifrontes). In Microdiscus, however, the larval facies is maintained by the large size of the anterior lobe as compared with those behind it. The Ptychopariæ in the Protoparis stage, which the author has studied, agree in having the somites of the cephalic axis short except the front one which is much larger and longer than the others; as regards the length, this is a permanent characteristic in the typical Microdisci of the Olenellus zone, for in these the front lobe is nearly as long as the other three.†

As in Agnostus, and in many other trilobites the pygidium of Microdiscus is divided into an anterior and a posterior part, the latter distinguished by the imperfect segmentation of the rachis; this is very well seen in the section (Eodiscus) described hereafter, wherein the protopygidium is marked by a tubercle on the summit of each ring of the rachis, while on the neo-pygidium there is a row of low tubercles along the crest of the ring, similar to those on the lateral lobes (of *M. pulchellus*, etc.). The pygidium in this group by the appearance and subsequent effacement during growth of costæ on the side lobes shows the addition of somites beyond the number of those of the early stages; while in other sections as Dawsonia (see below) the surface moulding shows the cementing of additional segments to the front of the pygidium.‡

A general rule holds in the genus Microdiscus as to the increase of the number of rings in the rachis of the pygidium, according to the geological age of the species; the majority of those

*On many heads of adult examples of *M. speciosus* all these furrows are quite obliterated.

†*M. speciosus* and *M. lobatus*, but this is not the case with *M. Schucherti* in which this lobe is short as in the Microdisci of the Paradoxides beds.

‡See also the pygidium ascribed to *M. precursor*.

of the *Olenellus* zone have but few rings (4 to 6), but in the *Paradoxides* zone, species with many rings (8 to 10 or even 12), are multiplied. The late Prof. C. F. Hartt recognized the distinction between these two sections of the genus as it occurs in the *Paradoxides* beds, giving to one the name *Dawsonia* and to the other *Eodiscus*. The following scheme will show how the species of *Microdiscus* are related to each other:

long glabella	Lateral lobes of pygid. ribbed	occipital ring obtusely pointed	Pygidial rachis has 4 rings	Section LOBATUS lobatus, Hall, 1847*	Horizon.
	pygidium unknown		unknown	Meeki, Ford, 1876	Olenellus Zone.
	ribbed		6 rings	Parkeri, Walc., 1886	
	smooth		6 rings	Helena, Walc., 1889	
	smooth smooth		12 rings 10 rings	Section SPECIOSUS speciosus, Ford, 1874 bellicinctus, Shaler & F., 1888	Olenellus Zone.
short glabella	several costae on the pygidium	occipital ring spined	6 to 7 rings	Section DAWSONIA †	Paradoxides lamellatus Sub-zone.
			6 rings	Dawsoni, Hartt, 1868 sculptus, Hicks, 1871	
	no costae on the side lobes of the pygidium.	occipital ring obtusely pointed	6 rings	Section EODISCUS ‡	Olenellus Zone.
			6 rings	Schucherti, n. sp.	Olenell. z. (?)
		occipital ring spined	unknown	connexus, Walc., 1887	Paradoxides eteminicus Sub-zone.
			12 rings	precursor, Matt., 1885	P. Abenacrus sub-zone.
			12 rings	suecicus, Linns., 1892	Paradoxides Davidis sub-zone.
			10 rings	pulchellus, Hartt, 1884	
			9 rings	punctatus, Salter, 1864‡ eucentrus, Linns., 1882	

* First published as an *Agnostus*.

† Used by Hartt for *M. Dawsoni*, published by Dawson, 1868.

‡ Name used by Hartt (probably about 1870), not published until 1884.

§ The type of the genus.

The embryonic tests of individuals of the section *Eodiscus* do not show any characters special to the genus, but these speedily appear in very small larval tests, and are first recognizable in the headshield. In general outline and in having costal ribs on the sides of the pygidium, this part of a young *Eodiscus* is much like that of a *Ptychoparia* at the corresponding stage, but in the later moults the distinctive features of *Microdiscus* appear; the rings of the axis become more numerous, the pleural lobes inflated and the form of the pygidium more elongated. In the species of this section (*Eodiscus*) the furrow on the pleuræ (of the posterior joint at least) run forward and outward as in *Agnostus*; this is perhaps due to the strong geniculation of the anterior marginal fold of the pygidium, necessitating a convexity of the overlapping pleura.

The genus *Microdiscus* serves as a link between the *Paradoxides* and the *Olenellus* faunas, and there is a gradation of resembling species through two lines of development, one with few, the other with numerous joints in the rachis of the pygidium. Though *Microdiscus* is so common in the *Olenellus* Fauna and passes into that of *Paradoxides*, no example has been found in the *Protolenus* Fauna.

★
MICRODISCUS SCHUCHERTI ~~n. sp.~~ Plate xvii., figs. 4 a and b.

Headshield subcircular, one-quarter wider than long, flattened in front, drawn in and upturned at the genal angles; axis projecting behind. Anterior marginal fold enclosing a flattened area, which is indented in front of the glabella. Glabella two-thirds of the length of the shield, cylindro-conical, depressed in front, elevated and projecting backward behind; three pairs of furrows faintly impressed on the sides. Occipital ring not visible. Cheeks moderately arched, not meeting in front of the glabella. Posterior marginal fold wide at the outer end, shield narrower here than opposite the cheeks.

Thorax not known, but the relief of the approximate margins of the two shields indicates a prominent rachis and strongly geniculate pleuræ, with furrows directed forward.

Pygidium longer in proportion than the head shield, and more decidedly arched. Rachis nearly three-quarters of the length of the shield; it has about six joints, the anterior four prominent and each crowned with a tubercle. Side lobes sloping down to a flattened marginal fold, which is strongly geniculated in front, with an almost vertical outer slope.

Sculpture.—Surface of both shields minutely granulate.

**Amer. Geologist*, July 1896 (no figure)

Size.—Length of pygidium, 3 mm.; width, 4 mm.; the head-shield is somewhat shorter.

Horizon and Locality.—Limestone of the Olenellus Zone at Troy, N. Y. Collected by Mr. C. Schuchert and communicated to the author.

Though this species is not of the Paradoxides Zone, I have described and figured it here on account of its resemblance to the larval stages of certain Microdisci of that zone. It differs from others with which it occurs in its short glabella and broad, depressed head shield; in these points it is like *M. Dawsoni*. While the typical species of the Olenellus Zone have retained the occipital ring, it appears to be wanting or nearly effaced in this species, as in several species of the Paradoxides Zone, and in the Agnosti. The larval pygidia of the Eodisci (*M. pulchellus*, etc.) resemble the adult shield of this species in contour, number of rings in the rachis, etc. And it is to a fixed larval stage of this type, rather than to *M. pulchellus*, *M. punctatus* or *M. Dawsoni* that the author would look as the source of such a form as *M. connexus*, Walc.; for this species differs little from *M. Schucherti*, except in the extension of the occipital spine. All our examples of *M. Schucherti* show only the outer surface, and so it is not known whether the border fold of the head shield is crenulated within.

MICRODISCUS PRECURSOR. Plate xvii., fig. 7.

Microdiscus punctatus var. *precursor*, Trans. Roy. Soc. Can., vol. iii., pt. iv., p. 75, pl. vii., fig. 13.

Only the head shield of this species is with certainty known. It resembles *M. pulchellus*, but is more triangular in outline. The marginal rim is very narrow; the dorsal furrow is deep and wide and connected with the marginal furrow by a shallower furrow. Glabella shows two faint pairs of furrows at the sides,



Microdiscus precursor, supposed pygidium mag. $\frac{1}{2}$. (This figure should have been placed between figs. 4b and 8d on Plate xvii.)

on the inside of the test, smooth on the outside. The occipital ring bears a tubercle or short spine. The cheeks are tumid, nearly straight on the side next the dorsal furrow, to which they descend abruptly; at the posterior inner corner is a prominence which projects toward the glabella in front of the occipital ring.

Occurring at the horizon of this species there is a somewhat long semi-circular pygidium which may belong to this species; a young example possesses the following characters. It is one and a-half times as wide as long. Rachis narrow and prominent, about one-fifth of the width of the shield, and three-quarters of its length; two rings are divided off the front by transverse furrows, two others are marked by side furrows, and there is a posterior lobe twice as long as wide, not reaching the marginal fold. The side lobes are tumid and are traversed by transverse furrows; three in front have the appearance of anchylosed segments of the thorax; one behind is less distinct, and a fifth is faintly indicated. A low, narrow, obscure fold goes around the margin of the shield.

Sculpture.—There are minute scattered tubercle on the cheeks and glabella, and minute, rather obscure crenulations on the inner surface of the test at the marginal fold. The supposed pygidium is minutely granulated.

Size.—Length of the head shield, 2 mm.; width, $1\frac{1}{2}$ mm.

Horizon and Locality.—In the fine gray shales of Div. 1c² at Hanford Brook and Porter's Brook, St. Martin's, N. B., Canada.

This species has a general resemblance to *M. scanicus* of the Swedish Paradoxides beds as regards the head shield; but if the pygidium described above belongs here, the species is more nearly related to *M. Dawsoni* and *M. Schucherti*; the crenulations of the margin are similar to those of the section Eodiscus, but not so sharply marked or so noticeable.

MICRODISCUS DAWSONI, Hartt. Plate xvii, figs. 5 a to e.

Microdiscus Dawsoni, Hartt. Acad. Geol., 2d ed., p. 564, fig. 228.

Microdiscus Dawsoni, Walcott, U. S. Geol. Surv. Bull 10, p. 23, pl. ii., figs. 3 and 3a.

Microdiscus Dawsoni, Trans. Roy. Soc. Can., vol. iii., pt. iv., p. 75, pl. vii., figs. 11, a to c.

Description.—“Cephalic shield semilunar, with thickened border, crossed by numerous grooves running perpendicularly to the circumference. Glabella convex, narrow, rounded in front, conical and pointed behind, projecting beyond the posterior border, without furrows or occipital groove. Cheeks convex, no eyes and no traces of sutures, posterior angles of the shield with backwardly projecting spines. Pygidium subtriangular, with curved outlines, rounded in front and behind; middle lobe distinctly marked and divided into six segments; lateral lobes also divided; furnished with a narrow border.”

This is one of the most characteristic species of the P. lamel-

latus Subzone. The head shields in my examples are broadly semicircular; the glabella and cheeks slope downward in front below the level of the anterior marginal fold, which rises in front as a prominent, crenulated, transverse ridge; the glabella extends backward into a stout spine, slightly hooked downward at the extremity; the glabella and spine form together a fusiform axial lobe tapering to both ends, and the two parts are nearly on the same plane.

The thorax consists of two joints having rounded rings and the pleurae have broad furrows directed forward as in *Agnostus*.

The pygidium is angled in front, has seven segments in the rachis and five ribs on the lateral lobes, of which the posterior are strongly directed backward as on the Welsh *M. sculptus*, Hicks.

Sculpture.—This species is closely granulated on those parts of the test that are raised above the general surface, but not in the furrows.

Size.—Length of head, exclusive of spine, 3 mm.; width, 4 mm. Length and width of pygidium, the same. The occipital spine is 2 mm. long.

Horizon and Locality.—The fine gray shales of Div. 1 c¹ at St. John, Ratcliff Stream, Simonds' and Hanford Brook, St. Martin's, N. B., Canada, but nowhere plentiful.

Development of the Young.—The young head shield in this species differs widely from the adult. At the length of 1 mm. the front rim is narrow all around and no crenulation is visible; the cheeks are comparatively flat, and there is a flattened area within the rim indented with a depressed point in front of the glabella, which it touches as in *M. Schucherti*. The glabella is pointed behind but bears no spine. The genal angles are somewhat pointed. At 1½ mm. length of head shield, the rim begins to widen in front and shows shallow crenulations, and the flattened area still shows a depression in front of the glabella. The genal angles are sharp and the posterior marginal fold broadens at the end and is upturned as in *M. Schucherti*. The glabella has a long anterior lobe, as *M. speciosus* has in the adult stage. In the later moults the strongly crenulated widened margin and the development of the occipital spine easily distinguish this species from the former of those above named, and the breadth of the shield and wide anterior rim from the latter.

I have not met with the genal spines described by Prof. Hartt, but the indrawn and upturned genal angle of the head shield forcibly recall similar features in more than one species of *Microdiscus* of the Olenellus Zone.

Although the pygidium of our species and that of *M. sculptus* are alike, the head shields are quite different, and the number of thoracic joints differs.

MICRODISCUS PULCHELLUS, Hartt. Plate xvii., fig. 8 *a* to *f*.

Microdiscus punctatus (Salter) Whiteaves. Am. Jour. Sci., 3 ser., vol. xvi., p. 225.

Microdiscus pulchellus, Hartt, Ms. in List to Sir J. W. Dawson.

Microdiscus punctatus, Walcott, U. S. Geol. Surv., Bull. 10, p. 24, pl. ii., figs. 1 *a* to *c*.

Microdiscus punctatus var. *pulchellus*, Trans. Roy. Soc. Can., vol. iii., pt. iv., p. 74, pl. vii., figs. 12 *a*, *b* and *c*.

Description (by Mr. C. D. Walcott).—"Head semi-elliptical in outline, rather strongly convex, and bordered on the front and sides by a depressed furrow and raised rim, the furrow containing numerous short furrows perpendicular to the margin, as in *M. Dawsoni*, but not as strongly marked. The posterior border is strong back of the cheeks, and has the furrow continuing from the sides; a very narrow rim extends back of the glabella; eyes and facial sutures entirely absent.

"Glabella elongate conical, extending backward in a strong spine, as long as the glabella in medium-sized specimens, and nearly as broad at the base. In some examples the spine is shorter and smaller. The glabella rises above the level of the cheeks, and is about three-fifths of the length of the head, bordered by strong dorsal furrows that are connected in front by a straight furrow with the depressed groove within the anterior marginal border, perceptibly marked by two pairs of oblique glabellar furrows in some examples. Cheeks convex, prominent, strongly defined by the dorsal and marginal furrows.

"Thorax unknown." [see below].

"The pygidium, associated with the head of this species in great numbers, has the same general outline as the head. The narrow, margined rim is well defined all around, widest at the sides; anterior marginal furrow very distinct; median lobe elongate conical, extending back nearly to the marginal groove; nine anchylosed segments are indicated by eight rather strong, transverse furrows; lateral lobes strongly convex, no furrow appearing back of the anterior marginal groove."

Sculpture.—"Surface finely punctate, the punctæ being rather large as compared with the depth.

Size.—Dimensions of a rather broad head. Length, 3.5 mm. (also $4\frac{1}{2}$ mm.). Pygidium, length, 3.75 mm. (also $4\frac{1}{2}$ mm.).

Breadth, 5 mm. There is considerable variation in the proportion of the parts.

"This is an abundant and well-marked species. The pygidium is very similar to that of *M. speciosus*, Ford, of the Olenellus Fauna. In event of the two forms *M. punctatus* and *M. pulchellus* proving distinct, I propose that Mr. Hartt's name, *M. pulchellus*, be given to the American species.

The following particulars may be added to the description of this form given by Mr. Walcott, in Bulletin 10.

The occipital spine is much more slender in the author's examples than in those figured by Mr. Walcott; it is flattened at the sides, and frequently rises from the plane of the head shield at an angle of 45° .

The short, transverse furrows on the marginal fold of the head shield differ from those of *M. Dawsoni* in being closer together and at about equal distances all around the margin; they are not on the outer surface of the fold, but only indent the inner surface of the test, hence they are not visible from above when the test is perfect.

No complete thorax has been found in connection with the shields, but the separated joints show a strong axial ring which has a row of obscure tubercles along the ridge similar to those on the posterior rings of the rachis; the pleuræ are strongly arched, and have a long and deep furrow directed somewhat obliquely backward; they seem not very rigid and terminate in rounded points.

According to Mr. Walcott the median lobe of the pygidium has eight segments, including the articulating ring, but well grown examples show nine well marked rings, and three other smaller, less distinct ones, near the end of the rachis. When one-quarter grown this species has seven distinct rings in the rachis, the number in the mature *M. punctatus*, according to Mr. Salter. From this species *M. pulchellus* differs not only in respect to the number of these rings, but also in having a smaller and more erect occipital spine.

Sculpture.—The test of *M. pulchellus* has been described as punctate, but this remark applies only to the head shield and thorax, for the pygidium is tuberculate on the side lobes. It may be added that the strong rings of the rachis carry each a low spine at the summit; but on the weak posterior rings the crest is ornamented with a row of small tubercles.

Size.—The dimensions given above are of the largest shields, more frequently it is a third smaller.

Development of the Young.—The change of this species as it grew from a Protaspis stage similar to that of other trilobites

associated with it, is partly shown by immature tests that have been observed. It acquired generic characters at a very early stage so far as the head shield is concerned, but the pygidium took a longer time. The Protaspis (slightly over $\frac{1}{2}$ mm. in length) is remarkable for the equal spacing of the somites almost from the first, causing the first somite to be smaller, and the first furrow further forward than usual; while the cephalic portion of the axis is visibly segmented, the caudal is not, and the line of suture between the two shields is scarcely indicated; the rachis almost touches a faintly defined rim at the back of the shield. In the $\frac{1}{2}$ mm. stage of the head shield the glabella is already near the normal form in the adult, but extends farther forward, and the furrow in front is short and deeply impressed, as in the young of *M. Dawsoni* and the adult of *M. Schucherti*; there is a slender occipital spine elevated at an angle from the plane of the head shield as in the adult. When the head shield is 1 mm. long the crenulation on the interior of the front rim of this shield becomes visible, and very short genal spines are added to the posterior angles.

When the pygidium was $\frac{1}{2}$ mm. long it had three lobes in the rachis and one rib marked off by a faint furrow at the front of the lateral lobes; this furrow is distinct only in the middle of its length; at this stage the shield is much flatter and wider than the adult and is bordered by a broad rim, within which is a broad rounded furrow. The $\frac{3}{4}$ mm. shield does not differ much in form, but has four rings in the rachis, and the rib at the front of each cheek is more distinctly marked. In the $1\frac{1}{2}$ mm. stage there are seven lobes to the rachis and only a faint trace of the rib on the front of the side lobe. In the 2 mm. stage there are seven strong lobes and three faint lobes on the rachis, and no trace of the rib on the side lobe, so that at this stage the pygidium has nearly assumed the aspect of the adult shield.

Horizon and Locality.—All parts of the St. John Basin, in the beds carrying the Abenacus Sub-fauna Div. 1 d^1 . Also in Kennebecases and Long Reach Basins at the same horizon.

MICRODISCUS PUNCTATUS, Salter.

Microdiscus punctatus, Salter, Quart. Jour. Geol. Soc. vol. xx., no. 79, p. 237, pl. viii., fig. 11.

c. f. *Microdiscus eucentrus*, Linrs. De Under Paradoxideslagren vid Andrarum, Stockholm, 1883, p. 30, tab. 4, figs. 19 and 20.

J. W. Salter's description of this species is as follows: "Head without eyes or facial suture; margined, the glabella and side lobes very prominent, punctate. An enormous nuchal spine.

Body rings 4. Tail equal to the head, with a strong 7-ringed axis, and smooth punctate sides, margin distinct."

G. Linnarsson's description of *M. eucentrus* is the following: Equalling the preceding (*i. e. M. Scanicus*), but the head more convex; glabella without any occipital furrow behind, prolonged into a spine longer than the head.

Linnarsson's species is evidently very near to Salter's, if not identical with it; the Swedish naturalist points to the larger number of joints in the pygidium of his species as distinctive of it, also to the absence of the crenulate border of the head shield. But I think Salter's "7 rings" to the axis of the pygidium refers only to the more distinct joints in the main part of the axis; and as for the ornamentation of the front rim of the head shield (unless the Welsh are different from the American species) that exist only on the interior of the rim, and would not appear on the outer surface of the test.

The young tests of *M. punctatus* show almost the same progressive changes from the embryonic form as *M. pulchellus*; among these are the acquisition and subsequent disappearance of a rib on the front of the side lobes of the pygidium; occasionally two ribs are thus developed, but in the adult these larval ribs disappear.

Sculpture.—The surface both of the head shield and pygidium are ornamented with close punctures, differing thus from *M. pulchellus* in which the surface of the pygidium is covered with small tubercles, while the head shield only is punctate.*

Size.—Length of largest head, exclusive of spine, 5 mm., length of spine 5 mm. (smaller heads show a spine longer in proportion); width of head shield, 6 mm. The pygidium is of the same size (excluding the occipital spine).

Horizontal and Locality.—In the fine gray shales of the P. Davidis Subzone at Manuel Brook, Conception Bay, Newfoundland. Common.

EXPLANATION OF PLATES.

PLATE XIV., CIRRIPIEDIA, ETC.

Notation of the horizons, used below:

Div. 1c¹. Horizon of *Paradoxides lamellatus*.

Div. 1c². Horizon of *Paradoxides Eteminiensis*.

Div. 1d¹. Horizon of *Paradoxides Abenacus*.

Div. 1d². Horizon of *Paradoxides Davidis*.

FIG. 1. *Stenotheca concentrica*. Flattened and cracked along the back. Mag. $\frac{1}{2}$. From Div. 1d¹, St. Martins, N. B. See p. 201.

* Pygidia occur, however, at Chapel Arm, Trinity Bay, Newfoundland, in the P. Davidis Subzone, having the surface tuberculate; the species has not been determined.

FIG. 2. *S. concentrica* var. *radiata*. Mag. $\frac{1}{2}$. From Div. 1 c, St. John, N. B. See p. 202.

FIG. 3. *Stenotheca Hicksiana*. Mag. $\frac{1}{4}$. From Div. 1 d', St. Martin's, N. B. See p. 205.

FIG. 4. *Stenotheca triangularis*. a, a cast of, showing the outline of the cone and the thickened apex. b, a cast without the outline. Both mag. $\frac{1}{4}$. From Div. 1 c, St. John, N. B. See p. 203.

FIG. 5. *Strobilepis spinigera*, J. M. Clarke. Terminal plate (and penultimate plate in outline). Figured for comparison from Dr. Clarke's restoration. Mag. $\frac{1}{2}$. The terminal plate is partly covered by the penultimate. Devonian species. See p. 203.

FIG. 6. *Stenotheca nasuta*. a, small example, mag. $\frac{1}{4}$. b, original type mag. $\frac{1}{4}$. Both from Div. 1 c, St. John, N. B. See p. 204.

FIG. 7. *Plumulites Manuelensis*, n. sp. mag. $\frac{1}{4}$. From Div. 1 d', Manuel Brook, Newfoundland. See p. 200. (Misprinted Plate XV. on p. 200.)

FIG. 8. Cirripedian and other plates. Type A, a and b, two forms of oval plates. Type B, a, ribbed plate; b, smooth plate. Type C, a, plate with deep furrow; b, plate with high umbo; c, plate with eared flange; d, plate similarly flanged but more regular; these are perhaps Cystidian. Type D, symmetrical plate, perhaps one of the axial row of plates. Type E, triangular plate with radiating ridges (possibly cystidian). Type F, triangular plate with arched keel (*Cirropodites Cambrensis*). Type G, triangular plate with faceted edges. All the figures except 8 G, a, mag. $\frac{1}{4}$ 8 G, a, is mag. $\frac{1}{4}$. The narrow figures beside the larger ones are sections. See p. 206.

PLATE XV., OSTRACODA AND AGNOSTUS (part).

FIG. 1. *Lepiditta alata*. a, outer surface of left valve. b, cast of interior of right valve. Mag. $\frac{2}{3}$. From Div. 1 c, St. John, N. B. See p. 194.

FIG. 2. *Lepiditta curta*. Interior of left valve. Mag. $\frac{1}{4}$. From Div. 1 d', St. Martin's, N. B. See p. 195.

FIG. 3. *Lepiditta auriculata*. a, left valve showing faint concentric lines and the ligamental (?) groove at the hinge. b, same, hinge line in profile. Mag. $\frac{1}{4}$. From shales of Div. 1 c, St. Martin's. See p. 196.

FIG. 4. *Aluta flexilis* n. g. et sp. left valve (with lower margin restored) showing ocular (?) tubercle. Mag. $\frac{1}{4}$. From conglomerate limestone band in Div. 1 c', St. Martin's, N. B. See p. 198.

FIG. 5. *Primitia Acadica*. a, left valve. b, longitudinal section. c, transverse section. Mag. $\frac{1}{4}$. From Div. 1 c', St. Martin's, N. B. See p. 198.

FIG. 6. *Agnostus fallax* var. *vir*. Complete, somewhat flattened. Mag. $\frac{1}{4}$. From Div. 1 c, St. John, N. B. See p. 215.

FIG. 7. *A. fallax* var. *concinus*. a, head shield. b, a joint of the thorax. c, Pygidium. Mag. $\frac{1}{4}$. From Div. 1 d', St. Martin's, N. B. See p. 216.

FIG. 8. Same variety. a, head shield of young larva retaining embryonic (Protaspis-like) features. Mag. $\frac{2}{3}$. b, young pygidium showing somites and posterior tubercle on rachis, effaced in later stages. Mag. $\frac{1}{4}$. Both from Div. 1 d', St. Martin's, N. B. See p. 216.

FIG. 9. *A. fallax* var. *trilobatus*, n. var. Pygidium. Mag. $\frac{1}{4}$. From Div. 1 c', St. John, N. B. See p. 216.

FIG. 10. *Agnostus Acadica*, Hartt. a, head shield. b, pygidium. Mag. $\frac{1}{4}$. From Div. 1 c', St. John, N. B. See p. 217.

FIG. 11. *A. Acadicus* var. *declivis*. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. *c*, larval pygidium showing embryonic features. Mag. $\frac{1}{2}$. *d*, adult pygidium in the rachis of which are six somites. Mag. $\frac{1}{2}$. All from Div. 1 *d*¹, St. Martin's, N. B. See p. 219.

PLATE XVI., AGNOSTUS.

FIG. 1. *Agnostus regulus*. *a*, head shield. *b*, a joint of the thorax. *c*, Pygidium. Mag. $\frac{1}{2}$. From Div. 1 *c*¹. See p. 213.

FIG. 2. *Agnostus rex* Barr. var. *transectus* n. var. Pygidium, Mag. $\frac{1}{2}$. From Div. 1 *d*¹, St. Martin's. See p. 214.

FIG. 3. *Agnostus parvifrons* Linns. var. *tessella*. *a*, head shield. *b*, thorax. *c*, pygidium, Mag. $\frac{1}{2}$. From Div. 1 *d*¹, St. Martin's, N. B. See p. 221.

FIG. 4. *Agnostus umbo*. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. From Div. 1 *d*¹, St. Martin's N. B. See p. 222.

FIG. 5. *Agnostus obtusilobus*. Mag. $\frac{1}{2}$. From Div. 1 *d*¹. St. Martin's N. B. See p. 223.

FIG. 6. *Agnostus Davidis*, Hicks. Pygidium. Mag. $\frac{1}{2}$. From Div. 1 *d*¹, Manuel Brook, Newfoundland. See p. 225.

FIG. 7. *Agnostus gibbus*, Linns. var. *partitus*. Head shield. Mag. $\frac{1}{2}$. From Div. 1 *c*¹, St. Martin's, N. B. See p. 227.

FIG. 8. *A. gibbus* var. *acutilobus*. Mag. $\frac{1}{2}$. From Div. 1 *d*¹, St. Martin's, N. B. See p. 227.

FIG. 9. *Agnostus Nathorsti*, Brugg, var. *confluens*, n. var. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. From Div. 1 *d*¹, St. Martin's, N. B. See p. 230.

FIG. 10. *Agnostus fassus*, Lundgr. var. *trifassus*, n. var. Mag. $\frac{1}{2}$. From Div. 1 *d*¹, St. Martin's, N. B. See p. 231.

FIG. 11. *Agnostus punctuosus*, Ang. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. From Div. 1 *d*², Highland Cove, Newfoundland. See p. 232.

PLATE XVII., AGNOSTUS AND MICRODISCUS.

FIG. 1. *Agnostus laevigatus*, Dalm., var. *terranovicus*, n. var. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. From Div. 1 *d*², Highland Cove, Newfoundland. See p. 233.

FIG. 2. *A. laevigatus* var. *mammilla*, n. var. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. From Div. 1 *d*², Highland Cove, Newfoundland. See p. 235.

FIG. 3. *A. laevigatus* var. *ciceroideus*, n. var. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. Found with the preceding. See p. 234.

FIG. 4. *Microdiscus Schucherti* n. sp. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. From Olenellus limestone, Troy, N. Y. See p. 238.

FIG. 5. *Microdiscus Dawsoni*, Hartt. *a*, head shield. *b*, same in profile. *c*, pygidium. Mag. $\frac{1}{2}$. *d*, young larval stage, head shield. Mag. $\frac{1}{2}$. *e*, next larval stage, head shield. Mag. $\frac{1}{2}$. All from Div. 1 *c*¹, St. John, N. B. See p. 240.

FIG. 6. *Microdiscus speciosus*, Ford. head shield. Mag. $\frac{1}{2}$. From Olenellus limestone, Troy, N. Y., figured for comparison. See p. 238.

FIG. 7. *Microdiscus precursor*. Head shield. Mag. $\frac{1}{2}$. From Div. 1 *c*¹, St. Martin's, N. B. See p. 239.

FIG. 8. *Microdiscus pulchellus* Hartt. *a*, head shield. *b*, same in profile. *c*, pygidium. Mag. $\frac{1}{2}$. *d*, embryonic or Protaspis stage. Mag. $\frac{1}{2}$. *e*, early larval stage. *f*, pygidium of same. Both Mag. $\frac{1}{2}$. All from Div. 1 *d*¹, St. Martin's, N. B. See p. 242.

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PLATE XIV., CIRRIPIEDIA, ETC.

Notation of the horizons, used below :

Div. 1c¹. Horizon of *Paradoxides lamellatus*.

Div. 1c². Horizon of *Paradoxides Etminicus*.

Div. 1d¹. Horizon of *Paradoxides Abenacus*.

Div. 1d². Horizon of *Paradoxides Davidis*.

FIG. 1. *Stenotheca concentrica*. Flattened and cracked along the back. Mag. $\frac{1}{2}$. From Div. 1 d¹, St. Martins, N. B. See p. 201.

FIG. 2. *S. concentrica* var. *radiata*. Mag. $\frac{1}{10}$. From Div. 1 c, St. John, N. B. See p. 202.

FIG. 3. *Stenotheca Hicksiana*. Mag. $\frac{1}{2}$. From Div. 1 d¹, St. Martin's, N. B. See p. 205.

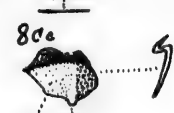
FIG. 4. *Stenotheca triangularis*. *a*, a cast of, showing the outline of the cone and the thickened apex. *b*, a cast without the outline. Both mag. $\frac{1}{2}$. From Div. 1 c², St. John, N. B. See p. 203.

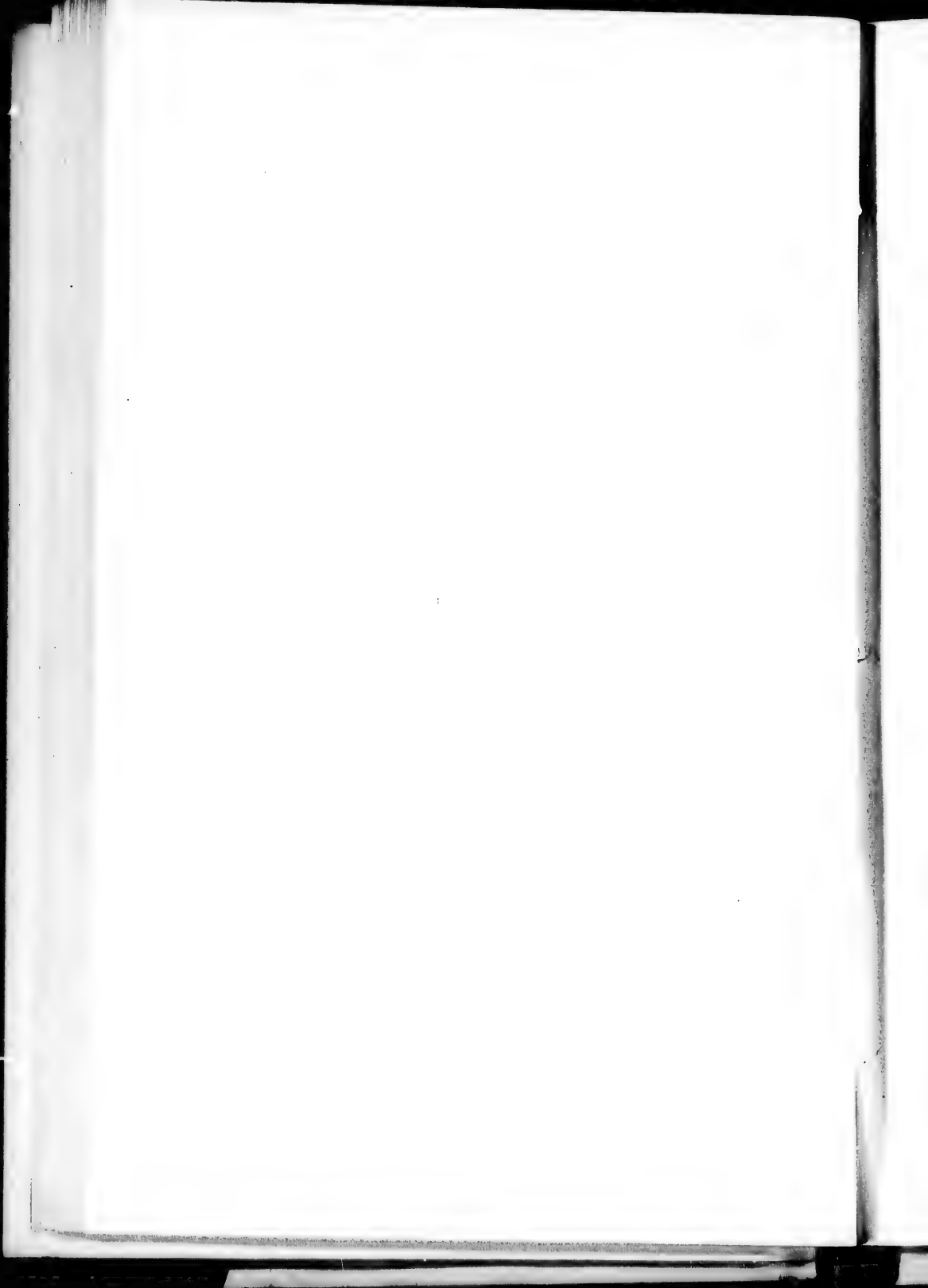
FIG. 5. *Strobilepis spinigera*, J. M. Clarke. Terminal plate (and penultimate plate in outline). Figured for comparison from Dr. Clarke's restoration. Mag. $\frac{1}{2}$. The terminal plate is partly covered by the penultimate. Devonian species. See p. 203.

FIG. 6. *Stenotheca nasuta*. *a*, small example, mag. $\frac{1}{2}$. *b*, original type mag. $\frac{1}{2}$. Both from Div. 1 c, St. John, N. B. See p. 204.

FIG. 7. *Plumulites Manuelensis*, n. sp, mag. $\frac{1}{2}$. From Div. 1 d², Manuel Brook, Newfoundland. See p. 200. (Misprinted Plate XV. on p. 200.)

FIG. 8. Cirripedian and other plates. Type A, *a* and *b*, two forms of oval plates. Type B, *a*, ribbed plate; *b*, smooth plate. Type C, *a*, plate with deep furrow; *b*, plate with high umbo; *c*, plate with eared flange; *d*, plate similarly flanged but more regular; these are perhaps Cystidian. Type D, symmetrical plate, perhaps one of the axial row of plates. Type E, triangular plate with radiating ridges (possibly cystidian). Type F, triangular plate with arched keel (*Cirropodites Cambrensis*). Type G, triangular plate with faceted edges. All the figures except 8 G, *a*, mag. $\frac{1}{2}$ 8 G, *a*, is mag. $\frac{1}{2}$. The narrow figures beside the larger ones are sections. See p. 206.





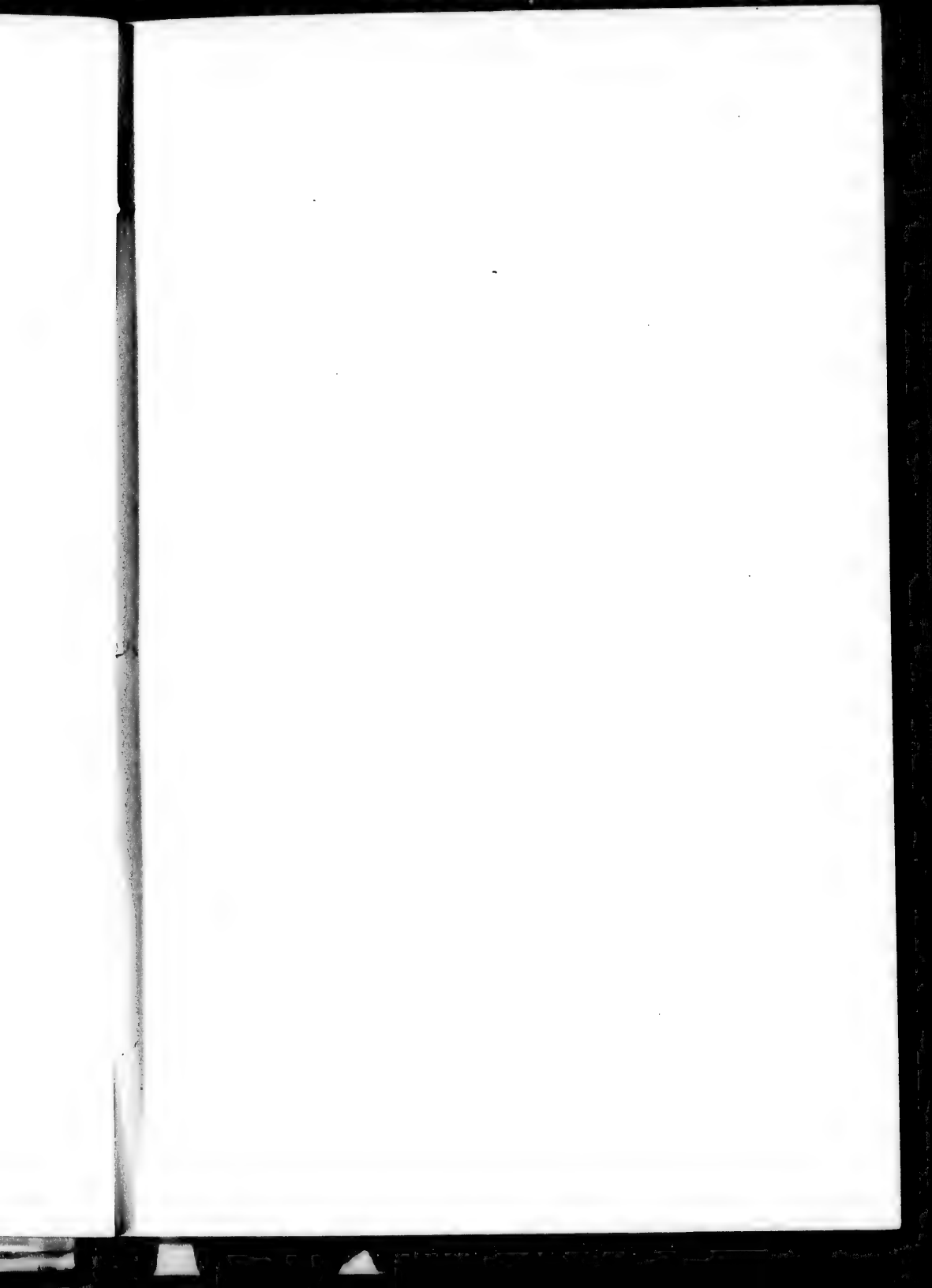


PLATE XV., OSTRACODA AND AGNOSTUS (part).

FIG. 1. *Lepiditta alata*. *a*, outer surface of left valve. *b*, cast of interior of right valve. Mag. $2\frac{1}{2}^{\circ}$. From Div. 1 c², St. John, N. B. See p. 194.

FIG. 2. *Lepiditta curta*. Interior of left valve. Mag. $1\frac{1}{2}^{\circ}$. From Div. 1 d¹. St. Martin's, N. B. See p. 195.

FIG. 3. *Lepiditta auriculata*. *a*, left valve showing faint concentric lines and the ligamental (?) groove at the hinge. *b*, same, hinge line in profile. Mag. $\frac{1}{2}$. From shales of Div. 1 c, St. Martin's. See p. 196.

FIG. 4. *Aluta flexilis* n. g. et sp. left valve (with lower margin restored) showing ocular (?) tubercle. Mag. $\frac{1}{2}$. From conglomerate limestone band in Div. 1 c¹, St. Martin's, N. B. See p. 198.

FIG. 5. *Primitia Acadica*. *a*, left valve. *b*, longitudinal section. *c*, transverse section. Mag. $\frac{1}{2}$. From Div. 1 c¹, St. Martin's, N. B. See p. 196.

FIG. 6. *Agnostus fallax* var. *vir*. Complete, somewhat flattened. Mag. $\frac{2}{3}$. From Div. 1 c², St. John, N. B. See p. 215.

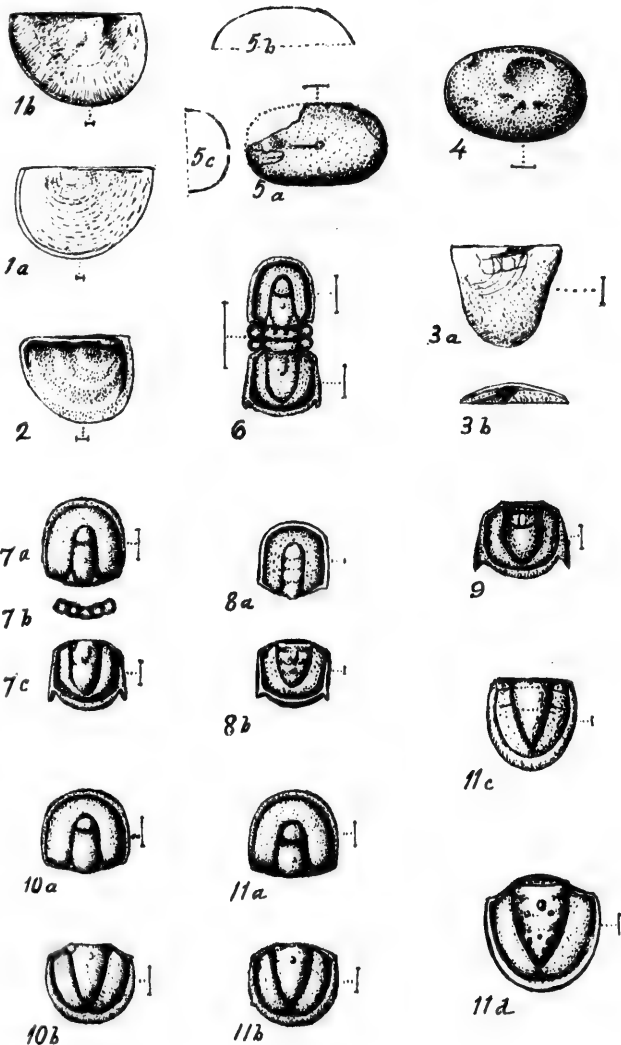
FIG. 7. *A. fallax* var. *concinnus*. *a*, head shield. *b*, a joint of the thorax. *c*, Pygidium. Mag. $\frac{1}{2}$. From Div. 1 d¹, St. Martin's, N. B. See p. 216.

FIG. 8. Same variety. *a*, head shield of young larva retaining embryonic (Protaspis-like) features. Mag. $2\frac{1}{2}^{\circ}$. *b*, young pygidium showing somites and posterior tubercle on rachis, effaced in later stages. Mag. $1\frac{1}{2}^{\circ}$. Both from Div. 1 d¹, St. Martin's, N. B. See p. 216.

FIG. 9. *A. fallax* var. *trilobatus*, n. var. Pygidium. Mag. $\frac{1}{2}$. From Div. 1 c¹, St. John, N. B. See p. 216.

FIG. 10. *Agnostus Acadicus*, Hartt. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. From Div. 1 c¹, St. John, N. B. See p. 217.

FIG. 11. *A. Acadicus* var. *declivis*. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. *c*, larval pygidium showing embryonic features. Mag. $1\frac{1}{2}^{\circ}$. *d*, adult pygidium in the rachis of which are six somites. Mag. $\frac{1}{2}$. All from Div. 1 d¹, St. Martin's, N. B. See p. 219.



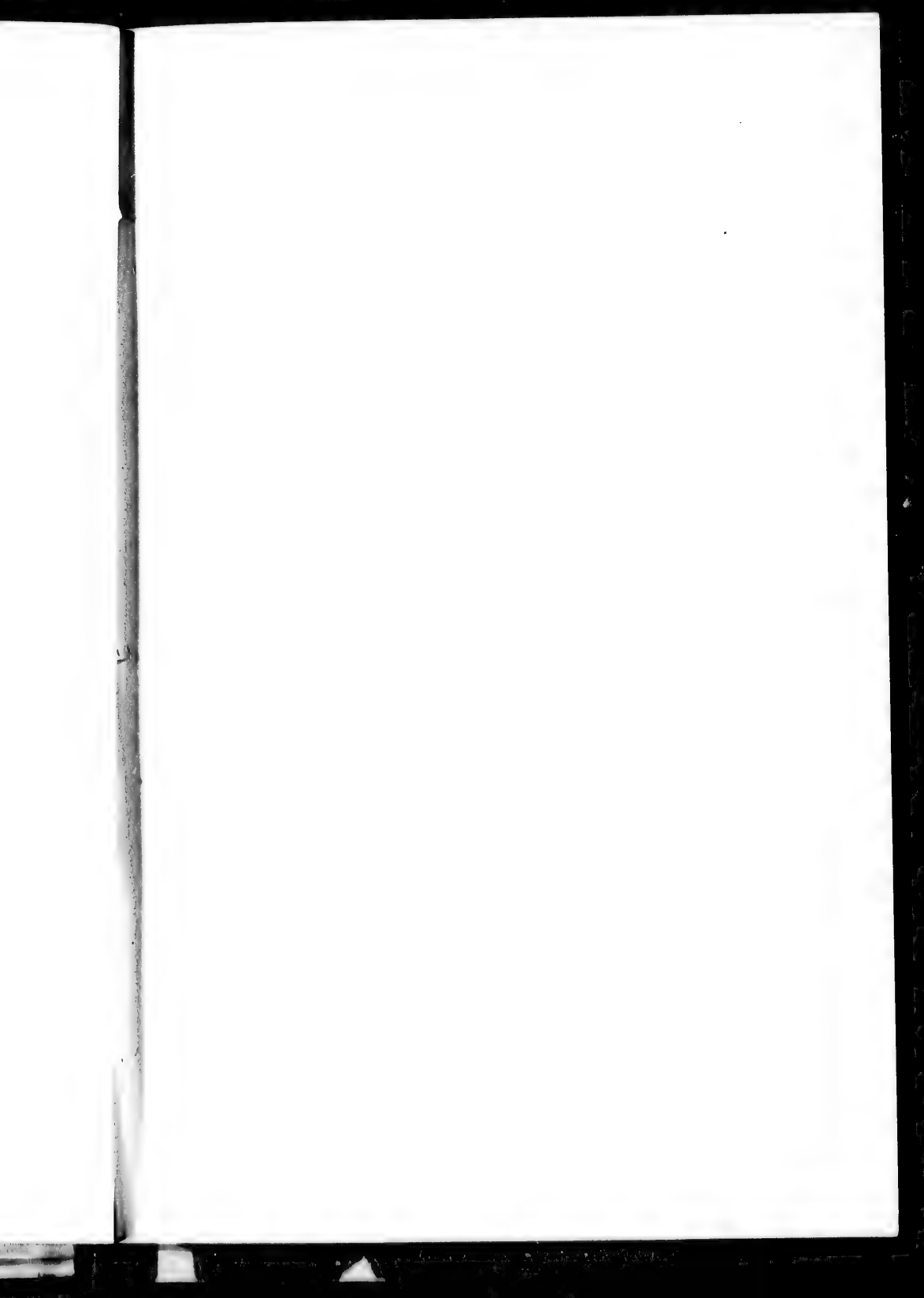


PLATE XVI., AGNOSTUS.

FIG. 1. *Agnostus regulus*. *a*, head shield. *b*, a joint of the thorax. *c*, Pygidium. Mag. $\frac{1}{4}$. From Div. 1 *c*². See p. 213.

FIG. 2. *Agnostus rex* Barr. var. *transectus* n. var. Pygidium, Mag. $\frac{1}{4}$. From Div. 1 *d*¹, St. Martin's. See p. 214.

FIG. 3. *Agnostus parvifrons* Lins. var. *tessella*. *a*, head shield. *b*, thorax. *c*, pygidium, Mag. $\frac{3}{4}$. From Div. 1 *d*¹, St. Martin's, N. B. See p. 221.

FIG. 4. *Agnostus umbo*. *a*, head shield. *b*, pygidium. Mag., $\frac{1}{4}$. From Div. 1 *d*¹, St. Martin's N. B. See p. 222.

FIG. 5. *Agnostus obtusilobus*. Mag. $\frac{3}{4}$. From Div. 1 *d*¹. St. Martin's N. B. See p. 223.

FIG. 6. *Agnostus Davidis*, Hicks. Pygidium. Mag. $\frac{3}{4}$. From Div. 1 *d*², Manuel Brook, Newfoundland. See p. 225.

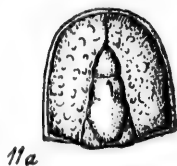
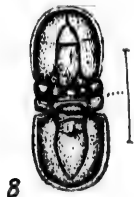
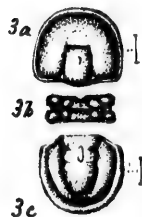
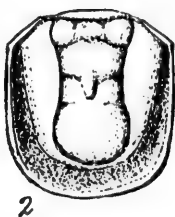
FIG. 7. *Agnostus gibbus*, Lins. var. *partitus*. Head shield. Mag. $\frac{1}{4}$. From Div. 1 *c*², St. Martin's, N. B. See p. 227.

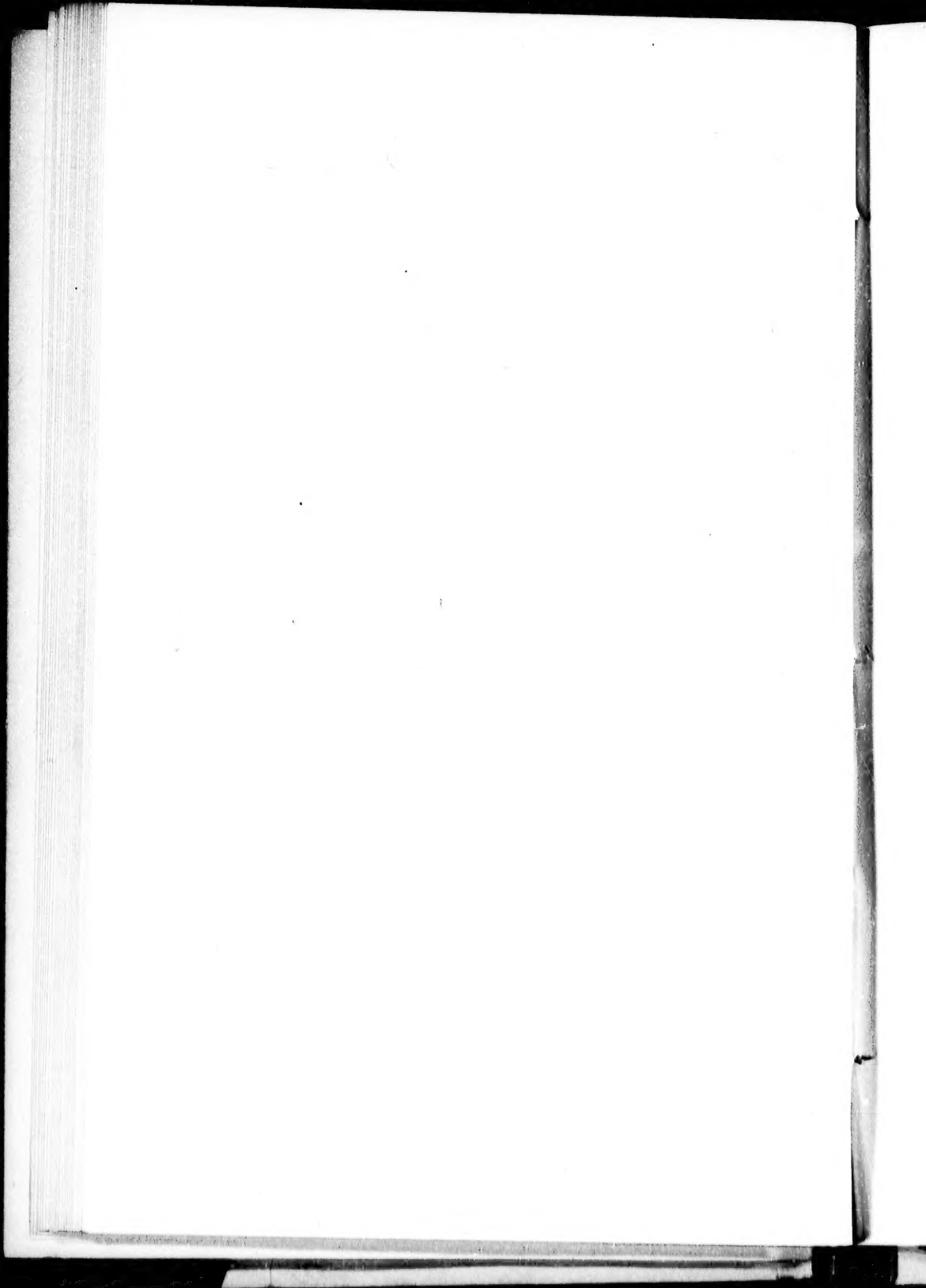
FIG. 8. *A. gibbus* var. *acutilobus*. Mag. $\frac{3}{4}$. From Div. 1 *d*¹, St. Martin's, N. B. See p. 227.

FIG. 9. *Agnostus Nathorsti*, Brögg, var. *confluens*, n. var. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{4}$. From Div. 1 *d*¹, St. Martin's, N. B. See p. 230.

FIG. 10. *Agnostus fissus*, Lundgr. var. *trifissus*, n. var. Mag. $\frac{1}{4}$. From Div. 1 *d*¹, St. Martin's, N. B. See p. 231.

FIG. 11. *Agnostus punctuosus*, Aug. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{4}$. From Div. 1 *d*², Highland Cove, Newfoundland. See p. 232.





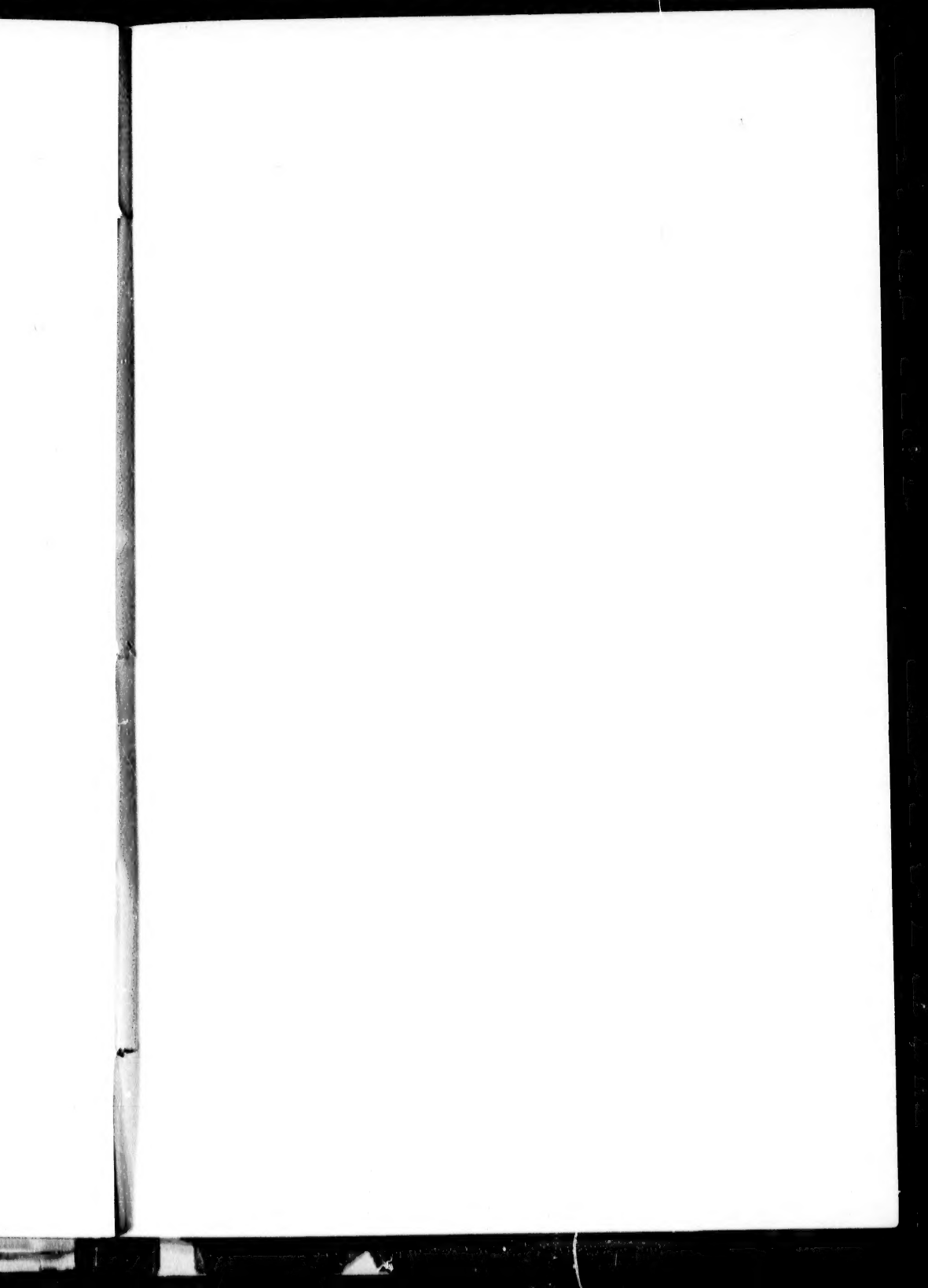


PLATE XVII., AGNOSTUS AND MICRODISCUS.

FIG. 1. *Agnostus levigatus*, Dalm., var. *terranoensis*, n. var. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. From Div. 1 d^2 , Highland Cove, Newfoundland. See p. 233.

FIG. 2. *A. levigatus* var. *mammilla*, n. var. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. From Div. 1 d^2 , Highland Cove, Newfoundland. See p. 235.

FIG. 3. *A. levigatus* var. *ciceroideus*, n. var. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. Found with the preceding. See p. 234.

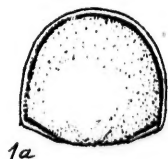
FIG. 4. *Microdiscus Schucherti* n. sp. *a*, head shield. *b*, pygidium. Mag. $\frac{1}{2}$. From Olenellus limestone, Troy, N. Y. See p. 238.

FIG. 5. *Microdiscus Dawsoni*, Hartt. *a*, head shield. *b*, same in profile. *c*, pygidium. Mag. $\frac{1}{2}$. *d*, young larval stage, head shield. Mag. $\frac{1}{10}$. *e*, next larval stage, head shield. Mag. $\frac{1}{10}$. All from Div. 1 e^1 , St. John, N. B. See p. 240.

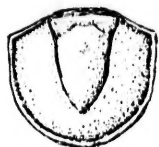
FIG. 6. *Microdiscus speciosus*, Ford. head shield. Mag. $\frac{1}{2}$. From Olenellus limestone, Troy, N. Y., figured for comparison. See p. 236.

FIG. 7. *Microdiscus precursor*. Head shield. Mag. $\frac{1}{2}$. From Div. 1 e^2 , St. Martin's, N. B. See p. 239.

FIG. 8. *Microdiscus pulchellus* Hartt. *a*, head shield. *b*, same in profile. *c*, pygidium. Mag. $\frac{1}{2}$. *d*, embryonic or Protaspis stage. Mag. $\frac{2}{10}$. *e*, early larval stage. *f*, pygidium of same. Both Mag. $\frac{2}{10}$. All from Div. 1 d^1 , St. Martin's, N. B. See p. 242.



1a



1b



5a



5b



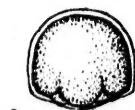
5c



5d



5e



2a



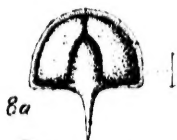
2b



6



7



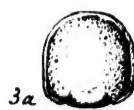
8a



8b



8c



3a



3b



4a



4b



8d



8e



8f